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FRESHWATER ASCOMYCETES: CYANOANNULUS PETERSENII, A NEW GENUS AND SPECIES FROM SUBMERGED WOOD

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ABSTRACT

During an inventory of freshwater euascomyetes in the Great Smoky Mountains National Park, a fungus (R044) with morphological characteristics similar to several genera in the Annulatascaceae was encountered on submerged wood. An identical fungus was also collected from La Selva Biological Station, Costa Rica. Generic placement based on morphological data alone was problematic, therefore phylogenetic analyses of 28S rDNA sequence was used to shed light on the relationship of R044 to other genera in the Annulatascaceae. Results from phylogenetic analyses indicate that R044 does not belong to any of the existing genera that have been included in the Annulatascaceae, thus a new genus, *Cyanoannulus*, is established to accommodate it. The characteristic features of the new genus are pale reddish brown ascomata, a two-layered peridium with cells darkened toward the outside, fusoid asci with a large, bipartite apical ring that is non-amyloid, but stains in aqueous cotton blue, and thick-walled ascospores with a narrow channel in their apical walls, with or without a gelatinous sheath. *Cyanoannulus petersenii* sp. nov. is described and illustrated.

KEYWORDS: Annulatascaceae, euascomycetes, fungi, systematics, 28S rDNA

INTRODUCTION

During an inventory of freshwater euascomycetes in the Great Smoky Mountains National Park (GSMNP), a fungus (R044) with morphological characteristics similar to several genera in the Annulatascaceae was found on submerged wood. This fungus is characterized by immersed to partly immersed, pale reddish brown ascomata with a two layered peridium composed of pseudoparenchymatic cells darkened toward the outer layer; septate paraphyses that are broad at the base and taper distally; narrowly fusiform, thin-walled, unitunicate asci with a bipartite, cylindrical apical apparatus that is non-amyloid, but stains blue in aqueous cotton blue; and fusiform or cylindrical, thick-walled, overlapping uni- to triseriate ascospores with a narrow channel in the apical walls and surrounded by an ephemeral gelatinous sheath.

The family Annulatascaceae was erected by Wong *et al.* (1998) to accommodate several genera of saprotrophic ascomycetes found on submerged wood and other decaying lignocellulosic material from the tropics. Currently 13 genera are included in the Annulatascaceae: *Annulatascus* K. D. Hyde, *Aquaticola* W. H. Ho *et al.*, *Aqualignicola* V. M. Ranghoo *et al.*, *Brunneosporella* V. M. Ranghoo & K. D. Hyde (as *Ascobrunneispora* in Ranghoo *et al.* 1999), *Cataractispora* K. D. Hyde *et al.*, *Clohiesia* K. D. Hyde, *Diluviocola* K. D. Hyde *et al.*, *Fluminicola* S. W. Wong, *et* al., *Frondicola* K. D. Hyde, *Pseudoproboscispora* Punith., *Submersisphaeria* K. D. Hyde, *Torrentispora* K. D. Hyde *et al.*, and *Vertexicola* K .D. Hyde *et al.*

Some morphological charactersistics of fungus R044, such as specifically the large bipartite apical ring and the thick-walled ascospores, are similar to those of species of *Annulatascus* (Hyde 1992), while the asci of R044 are relatively short and narrowly fusiform compared to those of *Annulatascus* species, which are long and cylindrical. The ascospores of R044 are relatively thick-walled with a channel in the apical wall and three-septate; none of the *Annulatascus* species have a channel in the ascospore apical wall and none of the species of *Annulatascus* with three-septate ascospores have thick ascospore walls. Fungus R044 is similar to *Torrentispora fibrosa* K.D. Hyde *et al.* in that they both have thick-walled ascospores but the ascospores are non-septate in *T. fibrosa* and three-septate in R044. The two taxa also differ in ascomatal and ascal morphology. The ascospores of some species of *Cataractispora* are three septate and have an apical chamber (Hyde *et al.* 1999) but the ascospores are narrow and appendaged and the asci are long and cylindrical, features not observed in R044. Fungus R044 is also similar to *Aquaticola hyalomura* W. H. Ho *et al.* in having light colored ascomata (Ho *et al.* 1999), while those of R044 are pale reddish brown. The asci of both of these taxa are relatively short compared to those of other taxa in the Annulatascaceae, however, fungus R044, has a large apical ring while the apical ring of *A. hyalomura* is much smaller. Given the problems in the generic placement of fungus R044, in addition to morphological data, we used 28S rDNA molecular sequence data to shed light on the relationship of this taxon to other genera in the Annulatascaceae.

The goals of this study were to fully characterize and describe the morphology of fungus R044, and to use morphology and phylogenetic analyses of molecular data to elucidate the phylogeny and taxonomy of this fungus.

MATERIALS AND METHODS

Morphological study

Submerged woody debris was collected from lotic and lentic habitats and transported to the laboratory in plastic bags containing paper towels. Water temperature, pH, and latitude and longitude were measured and recorded in the field. Woody debris was incubated in the laboratory in plastic boxes containing moistened paper towels at ambient temperatures (about 24° C) under 12/12h (light/dark) conditions. Samples were examined with a dissecting microscope immediately after collection and periodically over 12 months.

For initial examination, ascomata were removed from the substrate and crushed in a drop of distilled water on a glass slide. Staining reactions of the ascal apex were tested with Melzer's (MLZ) reagent (0.5g iodine, 1.5g KI, 20g chloral hydrate, 20 mL distilled water) and aqueous cotton blue. India ink or aqueous nigrosin was added to the aqueous mounts to reveal gelatinous sheaths around the ascospores. Measurements of the paraphyses, asci and ascospores were made of material mounted in distilled water.

Distilled water was replaced with lactic acid containing azure A or with glycerin for preservation using the double cover glass method (Volkmann-Kohlmeyer and Kohlmeyer 1996). Ascomata were fixed and embedded using a modification of Huhndorf's technique (1991): the osmium tetraoxide step was deleted, and acetone was used instead of ethanol for dehydration and infiltration (Huhndorf pers. com.).

Ascomata were sectioned following the procedures of Fallah and Shearer (2001). Digital images were obtained with a Spot RT digital camera using an Olympus microscope equipped with Nomarski interference and phase optics. Specimens were dried for deposition in the mycological herbarium of the University of Illinois at Urbana Champaign (ILL).

Table 1. Isolates sequenced for this study

Species	Isolate #	Country	GenBank accession #
Annulatascus biatriisporus K.D. Hyde	A464-3	Costa Rica	AY316352
Annulatascus triseptatus S.W. Wong *et al.*	R059	USA	AY316353
Annulatascus velatisporus K.D. Hyde	R047	USA	AY316355
Annulatascus velatisporus K.D. Hyde	A70-18	USA	AY316354
Aquaticola ellipsoidea W.H. Ho *et al.*	A411-3	USA	AY316356
Ascotaiwania hughseii Fallah *et al.*	P2-6	USA	AY316357
Cyanoannulus petersenii Raja *et al.*	R044-1a	USA	AY316358
Cyanoannulus petersenii Raja *et al.*	R044-1b	USA	AY316359

Molecular study

Cultures were obtained from single ascospores or asci according to the procedures of Shearer (1993) and grown on peptone-yeast-glucose (PYG) agar plates (0.125 % peptone, 0.125 % yeast extract, 0.6 % glucose, 1.8 % agar) for 6–8 weeks in the dark at 24 C (Table 1). Culture identities were confirmed using the procedures of Fallah and Shearer (2001).

DNA was extracted according to the procedures of Campbell *et al.* (2003b). Spores of fungus R044-1 would not germinate so DNA was extracted directly from ascomata (R044-1a, R0441-b). Both isolates of R044-1 were derived from the holotype collection that was obtained from the GSMNP. Three fruit bodies for each extraction were suspended in 400 μl AP1 buffer (DNeasy Plant Mini Kit, Qiagen 2000), incubated with 200 units of lyticase (Sigma Chemical Co, MO) at 30 C for four hours, and ground at hourly intervals during incubation using a micropestle. RNase A (40 mg) was added and incubated for 20 min at 65 C. The protocol was then followed from Step 4 of the DNeasy Plant Mini Kit (Qiagen 2000).

The 5’ end of the 28S rDNA (1100 bp) was amplified following the protocols of Campbell *et al.* (2003a, 2003b) and using primers JC1, designed for this project by J. Campbell, and LR6 (Vilgalys and Hester 1990). Primer JC1 is a tailed primer incorporating universal fungal primer LROR (Bunyard *et al.* 1994), with a sequencing primer (M13 forward –40) attached to the 5'– end of the PCR primer. The tailed primer consists of 34 base pairs: GTT TTC CCA GTC ACG ACA CCC GCT GAA CTT AAG C. Cycling parameters used were the same as described by Campbell *et al.* (2003b) for primers LROR and LR6.

The PCR products were purified to remove excess primers, dNTPs and non-specific amplification products using a Qiaquick PCR Purification Kit (Qiagen 2001) and sequenced directly using primers M13 forward –40 and LR6 at the University of Illinois Biotechnology Center using BigDye® Terminators v3.1 (Applied Biosystems, USA) on ABI 373A automated sequencers. The sequences were aligned with published sequence data (Table 2) in Clustal X (Thompson *et al.* 1997), then refined manually in Se-Al (Rambaut 2001). Ambiguous regions were removed from the alignment.

Phylogenetic Analyses

Representatives from all genera in the Annulatascaceae currently available in GenBank were included in our study (data set one), as well as species from other families in the Sordariales (Sordariaceae and Lasiosphaeriaceae). Available species from other orders of pyrenomycetous fungi with large or distinctive apical rings were also included (Diaporthales, Xylariales). Data set one was used to verify the taxonomic identity of the included Annulatascaceae sequences, with Saccharomycetales included to identify any yeast contaminants and Agaricales as an outgroup to ensure that all sequences were contained within the Ascomycota. Seven species of Annulatascaceae were excluded from our final analyses (data set two) based on the results of the analysis of data set one.

Cladistic analyses were performed with PAUP* (Swofford 2002) using maximum parsimony and weighted parsimony criteria. Data set one consisted of 50 sequences. Data set two consisted of 39 sequences. Outgroup comparison was used to polarize the character states and hence root the trees (Stevens 1980, Watrous and Wheeler 1981, Farris 1982, Darlu and Tassey 1987), employing the strategies of Maddison *et al.* (1984) and Campbell (1999). These strategies demonstrate that global parsimony is best achieved when the pleisomorphic states are indicated in a more distant ancestor than the most recent common ancestor of the ingroup taxa. Several basal ascomycetes and basidiomycetes were explored as outgroup taxa (data not shown). On the basis of reduced homoplasy and increased congruence in the phylogenetic reconstructions, species of Agaricales were chosen for data set one, and species of Pezizales were chosen for data set two.

Maximum parsimony analyses were performed with heuristic searches employing random starting trees, random stepwise addition on 100 replicates, gaps treated as missing data, and a tree-bisection-reconnection branch-swapping algorithm. Parsimony tree scores for the consistency index (CI), retention index (RI), rescaled consistency index (RC) and homoplasy index (HI) were calculated in PAUP* for each tree generated. Weighted parsimony analyses were performed using a step matrix to weight nucleotide transformations based on the reciprocal of the observed transition:transversion (ti/tv) ratio (Spatafora *et al.* 1998), which was calculated using MacClade (Maddison and Maddison 1992).

Table 2. Sequences retrieved from GenBank

Species	GenBank accession #
Agaricus arvensis Schaeff	U11910
Agaricus bisporus (Lange) Imbach	U11911
Annulatascus hongkongensis W.H. Ho *et al.*	AF132319
Annulatascus triseptatus S.W. Wong *et al.*	AY094186
Annulatascus velatisporus K.D. Hyde	AF132320
Aquaticola hongkongensis unpublished	AF132321
Ascocollumdensa aquatica unpublished	AF132325
Ascolacicola aquatica Ranghoo & K.D. Hyde	AF132322
Ascolacicola austriaca Réblová *et al.*	AF261067
Ascotaiwania mitriformis Ranghoo & K.D. Hyde	AF132324
Ascotaiwania sawada H.S. Chang & S.-Y. Hsieh	AF132323
Bionectria aureofulva (Cooke & Ellis) Schroers & Samuels	U88123
Bionectria ochroleuca (Schwein.) Schroers & Samuels	U00750
Brunneosporella aquatica Ranghoo & K.D. Hyde	AF132326
Candida lassenensis Kurtzman	AF017726
Cataractispora recepticuli unpublished	AF132327
Cercophora appalachianensis O. Hilber & R. Hilber	AF132328
Ceriosporopsis halima Linder	U47844
Clohiesia corticola K.D. Hyde	AF132329
Diaporthe eres Nitschke	AF362565
Discostroma sp.	U47828
Fluminicola coronata unpublished	AF132332
Gyromitra esculenta (Pers.) Fr.	U42675
Haligena salina C.A. Farrant & E.B.G. Jones	AY227116
Halosarpheia fibrosa Kohlm. & E. Kohlm.	AY094183
Helvella lacunose Afzel.	U42681
Lasiosphaeria ovina (Pers.:Fr.) Ces. & De Not.	AF064643
Lepteutypa cupressi (Nattrass, C. *et al.*) H.J. Swart	AF382379
Leucostoma niveum (Hoffm.) Höhn.	AF362558
Melanconis stilbostoma (Fr.) Tul. & C. Tul.	AF362567
Melanospora fallax Zukal	U17404
Melanospora zamiae Corda	U17405
Morchella esculenta (L.) Pers.	AF279398
Pseudoproboscispora caudae-suis (Ingold) J. Campb. *et al.*	AY094191
Pseudoproboscispora caudae-suis (Ingold) J. Campb. *et al.*	AY094192
Saccharomyces cerevisiae Meyen	U44806
Sordaria fimicola (Rob.) Ces. & De Not.	AF132330
Submersisphaeria aquatica K.D. Hyde	AY094193
Submersisphaeria aquatica K.D. Hyde	AY094194
Valsa germanica Nitschke	AF362561
Vertexicola confusa unpublished	AF132331
Xylaria curta Fr.	U47840

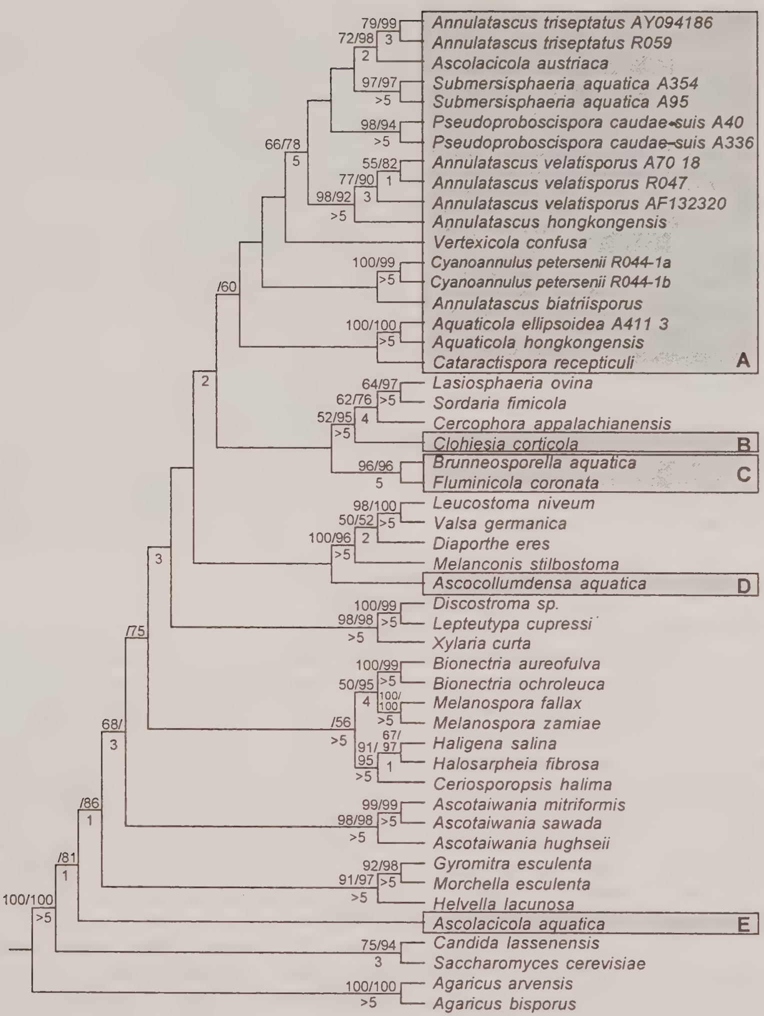
Alternative tree topologies were tested using the Kishino-Hasegawa (K-H) maximum likelihood test (Kishino and Hasegawa 1989) to find the best or most likely tree. Decay indices (Bremer 1988, 1994) were calculated in AutoDecay (Eriksson 1998). Bayesian inference of phylogeny (Rannala and Yang 1996, Zhaxybayeva and Gogarten 2002) was calculated using MrBayes v2.01 (Huelsenbeck and Ronquist 2001), which calculates the posterior probability that a tree topology is correct for a given data set using Markov Chain Monte Carlo methods. The data set was analyzed using MrBayes with general time reversible (GTR) model of substitution (Rodriguez *et al.* 1990) and a gamma-distributed rate variation across sites, with a proportion of the sites being invariable. Base frequencies and rates for GTR were estimated by MrBayes, gamma shape was initially calculated in PAUP* for the best tree, and this result was then used in MrBayes. Four simultaneous Markov chains were run from random starting trees for 1,000,000 generations and sampled every 100 generations (generating 10,001 trees). With data set one, the first 59,800 generations (598 trees) of the chain were discarded as burn-in (the time for the chain to reach stability), and inferences of posterior probability were made on 403 trees. For data set two, the first 17,400 generations (174 trees) of the chain were discarded as burn-in and inferences of posterior probability were made on 9,827 trees.

RESULTS

Data set one

Of 836 unambiguously aligned characters, 462 were parsimony informative (~55 %). Maximum parsimony analysis resulted in 28 most parsimonious trees. A K-H test (data not shown) indicated which tree was the best tree for this data set (Fig. 1).

Species of Annulatascaceae are dispersed among five widely separated clades (Fig. 1, clades A–E). The majority of the Annulatascaceae species and *Cyanoannulus petersenii* occur on a monophyletic clade (Fig. 1, clade A) within the Sordariales. However, five species of Annulatascaceae, obtained from Genbank, are placed in other orders and/or families: *Clohiesia corticola* is placed within the Lasiosphaeriaceae/ Sordariaceae clade (Fig. 1, clade B), which conflicts with its published morphology (Hyde 1995); *Brunneosporella aquatica* is placed within the Sordariales, but on a sister clade to the Lasiosphaeriaceae/ Sordariaceae clade (Fig. 1, clade C), which conflicts with its published morphology (Ranghoo *et al.* 2001); the sequence of *Fluminicola coronata* is placed with *B. aquatica* on a monophyletic clade as sister taxa to the Lasiosphaeriaceae/ Sordariaceae clade (Fig. 1, clade C), but the species description has not been published; *Ascocollumdensa aquatica* is placed within the Diaporthales (Fig. 1, clade D), but the species description has not been published; and *Ascolacicola aquatica* is placed basal to the Pezizales (Fig. 1, clade E), which conflicts with its published morphology (Ranghoo and Hyde 1998). Two additional sequences from GenBank, *Cataractispora recepticuli* and *Vertexicola confusa,* are placed within the monophyletic clade of Annulatascaceae species (Fig. 1, clade A), but morphological descriptions have not been published. These seven sequences were excluded from further analyses as the placement of three species is in conflict with their published morphology, and four of the species do not have published descriptions so their morphology is not known.


79/99
72/98
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97/97
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98/94
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77/90
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98/92
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>5
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>5
/60
100/100
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64/97
62/76
>5
52/95
4
>5
96/96
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98/100
50/52
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100/96
2
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68/
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98/98
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1
100/100
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75/94
3
100/100
>5
Annulatascus triseptatus AY094186
Annulatascus triseptatus R059
Ascolacicola austriaca
Submersisphaeria aquatica A354
Submersisphaeria aquatica A95
Pseudoproboscispora caudae-suis A40
Pseudoproboscispora caudae-suis A336
Annulatascus velatisporus A70 18
Annulatascus velatisporus R047
Annulatascus velatisporus AF132320
Annulatascus hongkongensis
Vertexicola confusa
Cyanoannulus petersenii R044-1a
Cyanoannulus petersenii R044-1b
Annulatascus biatriisporus
Aquaticola ellipsoidea A411 3
Aquaticola hongkongensis
Cataractispora recepticuli
A
Lasiosphaeria ovina
Sordaria fimicola
Cercophora appalachianensis
Clohiesia corticola
B
Brunneosporella aquatica
Fluminicola coronata
C
Leucostoma niveum
Valsa germanica
Diaporthe eres
Melanconis stilbostoma
Ascocollumdensa aquatica
D
Discostroma sp.
Lepteutypa cupressi
Xylaria curta
Bionectria aureofulva
Bionectria ochroleuca
Melanospora fallax
Melanospora zamiae
Haligena salina
Halosarpheia fibrosa
Ceriosporopsis halima
Ascotaiwania mitriformis
Ascotaiwania sawada
Ascotaiwania hughseii
Gyromitra esculenta
Morchella esculenta
Helvella lacunosa
Ascolacicola aquatica
E
Candida lassenensis
Saccharomyces cerevisiae
Agaricus arvensis
Agaricus bisporus

Figure 1. Cladogram generated under maximum parsimony criteria (length 2773, CI=0.44, RI=0.56, RC=0.25), inferred from 28S rDNA sequence data with Agaricales as outgroup taxa. Maximum parsimony bootstrap values and Bayesian posterior probabilities, respectively, are shown for values greater than 50% above the branches, and decay indices are shown below the branches. Species of the Annulatascaceae are shown in highlighted boxes.

Data set two

Of 836 unambiguously aligned characters, 347 were parsimony informative (~42%). Maximum parsimony analysis resulted in six most parsimonious trees and weighted parsimony analysis (ti/tv = 1.34) generated one most parsimonious tree. A K-H test of the unweighted trees indicated which tree from that analysis was the best tree. A further K-H test (Table 3) of the best unweighted tree and the tree from the weighted parsimony analysis indicated that the tree from the unweighted analysis was the best phylogenetic hypothesis for this data set (Figs. 2 & 3).

The family Annulatascaceae is monophyletic within the Sordariales (Fig. 2, clade A). *Annulatascus*, the type genus of Annulatascaceae, is polyphyletic. The four included species of *Annulatascus* are dispersed among three separate clades (Fig. 2, clades B, C, D). Isolates a and b of *Cyanoannulus petersenii* are placed on a clade (Fig. 2, clade E) with *Annulatascus biatriisporus.*

Table 3. Results of Kishino-Hasegawa tests on alternative tree topologies

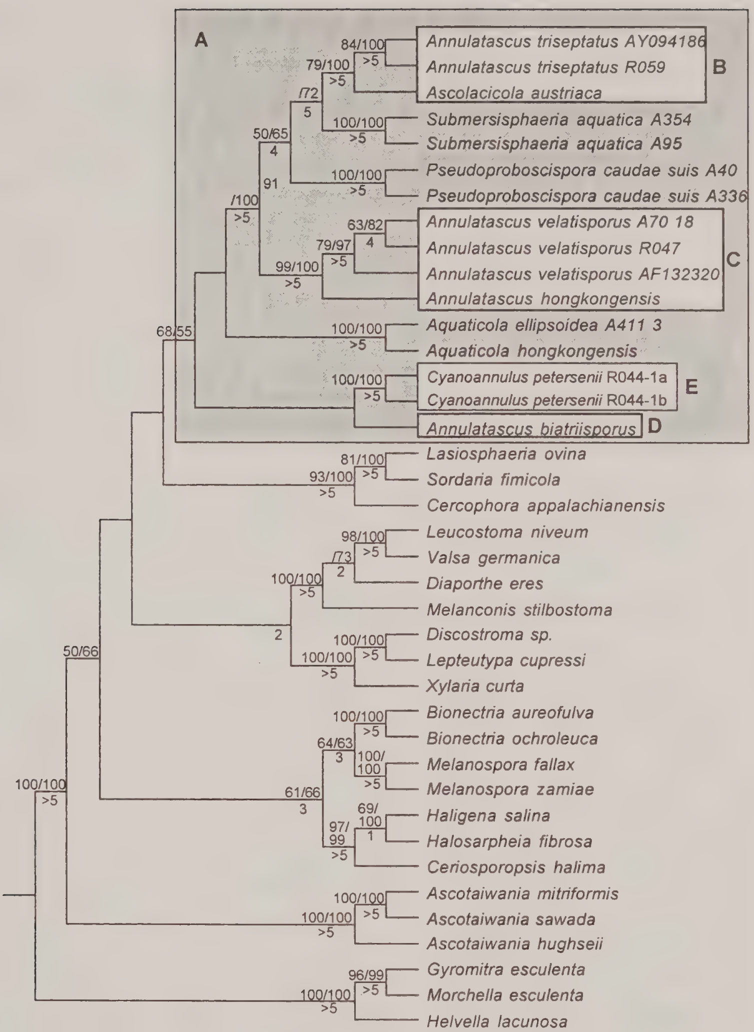
Analysis	No of trees	Tree length	-ln likelihood	Diff. –ln likelihood	*P* value ($P < 0.05$)
Unweighted parsimony	6	1623	8977.613	(best)	
Weighted parsimony (ti/tv = 1.34)	1	1623	8983.449	5.836	0.000*

TAXONOMY

Cyanoannulus Raja, J. Campb. *et* Shearer, gen. nov.

Ascomata dispersa, immersa ad partim immersa, leviter horizontalia, globosa ad subglobosa, ostiolata, pallida rubra brunnea. Peridium e *textura angularis* in facei, longitudinem bistratum: stratum interior hyalinum pseudoparenchyma; stratum exterior e cellulae parium fuscatorum. Collum centrale, longum, cylindricum, periphysium. Hamathecium paraphysibus, paraphyses septata, latae ad basem, angustata distales. Asci unitunicati, fusoidi, octospori, ad basim contractam, ad apicem complanatum, non amyloideus, cum apparatu apicali bipartis et digiti munimento, labis caerulei poirreri aquosi ope caerulescentum. Ascosporae crassiparibus, hyalinae, fusiformes, in unum latus complanatae, imbricatae uniseriatae, triseptatae, septa crassa, canali angustus ad apices, cum vel sine vagina muscilagina.

Ascomata scattered, immersed to partially immersed, slightly horizontal to the substrate surface, globose to subglobose, ostiolate, pale reddish brown. *Peridium* of *textura angularis* in face view, in longitudinal section composed of two regions, inner region of hyaline, thin-walled, elongated pseudoparenchymatic cells, outer region of thick-walled, dark cells. *Neck* central, long, cylindrical, periphysate. *Hamathecium* of hyaline, septate paraphyses constricted at the septa, broad at the base and tapering distally. *Asci* unitunicate, fusoid, 8-spored, tapering at the base, separating from the hymenial layer at maturity, flattened at the apex, with a non-amyloid, cotton blue positive, bipartite, cylindrical apical apparatus. *Ascospores* thick-walled, hyaline, fusiform, flattened on one side, overlapping uniseriate, three-septate, septa thick-walled, with a narrow channel at the apices, gelatinous sheath present or absent.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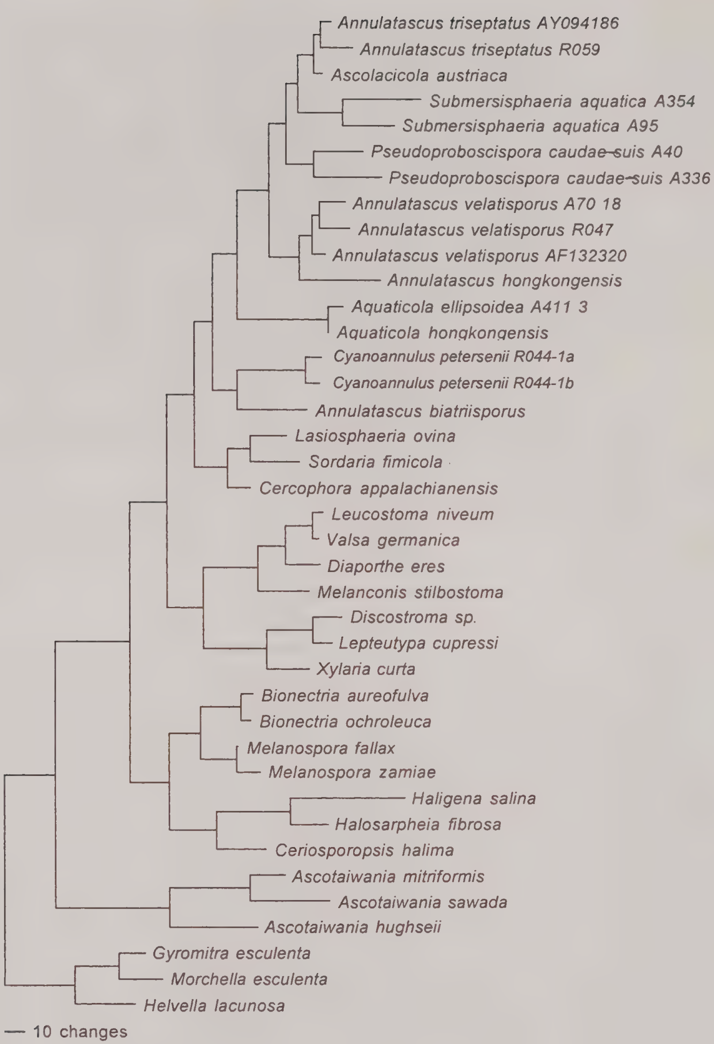
84/100
>5
Annulatascus triseptatus AY094186
79/100
>5
Annulatascus triseptatus R059
B
/72
5
Ascolacicola austriaca
100/100
>5
Submersisphaeria aquatica A354
50/65
4
Submersisphaeria aquatica A95
91
100/100
>5
Pseudoproboscispora caudae suis A40
/100
>5
Pseudoproboscispora caudae suis A336
63/82
4
Annulatascus velatisporus A70 18
79/97
>5
Annulatascus velatisporus R047
99/100
>5
Annulatascus velatisporus AF132320
C
Annulatascus hongkongensis
68/55
100/100
>5
Aquaticola ellipsoidea A411 3
Aquaticola hongkongensis
100/100
>5
Cyanoannulus petersenii R044-1a
E
Cyanoannulus petersenii R044-1b
Annulatascus biatriisporus
D
81/100
>5
Lasiosphaeria ovina
93/100
>5
Sordaria fimicola
Cercophora appalachianensis
98/100
>5
Leucostoma niveum
/73
2
Valsa germanica
100/100
>5
Diaporthe eres
Melanconis stilbostoma
2
100/100
>5
Discostroma sp.
100/100
>5
Lepteutypa cupressi
50/66
Xylaria curta
100/100
>5
Bionectria aureofulva
64/63
3
Bionectria ochroleuca
100/
100
>5
Melanospora fallax
100/100
>5
61/66
3
Melanospora zamiae
69/
100
1
Haligena salina
97/
99
>5
Halosarpheia fibrosa
Ceriosporopsis halima
100/100
>5
Ascotaiwania mitriformis
100/100
>5
Ascotaiwania sawada
Ascotaiwania hughseii
96/99
>5
Gyromitra esculenta
100/100
>5
Morchella esculenta
Helvella lacunosa

Figure 2. Cladogram generated under maximum parsimony criteria (length 1623, CI=0.49, RI=0.63, RC=0.31), inferred from 28S rDNA sequence data with Pezizales as outgroup taxa. Maximum parsimony bootstrap values and Bayesian posterior probabilities, respectively, are shown for values greater than 50% above the branches, and decay indices are shown below the branches. Species of Annulatascaceae and *Annulatascus* are shown highlighted in boxes.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Annulatascus triseptatus R059
Ascolacicola austriaca
Submersisphaeria aquatica A354
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Annulatascus velatisporus AF132320
Annulatascus hongkongensis
Aquaticola ellipsoidea A411 3
Aquaticola hongkongensis
Cyanoannulus petersenii R044-1a
Cyanoannulus petersenii R044-1b
Annulatascus biatriisporus
Lasiosphaeria ovina
Sordaria fimicola
Cercophora appalachianensis
Leucostoma niveum
Valsa germanica
Diaporthe eres
Melanconis stilbostoma
Discostroma sp.
Lepteutypa cupressi
Xylaria curta
Bionectria aureofulva
Bionectria ochroleuca
Melanospora fallax
Melanospora zamiae
Haligena salina
Halosarpheia fibrosa
Ceriosporopsis halima
Ascotaiwania mitriformis
Ascotaiwania sawada
Ascotaiwania hughseii
Gyromitra esculenta
Morchella esculenta
Helvella lacunosa
10 changes

Figure 3 . Phylogram generated under maximum parsimony criteria (length 1623, CI=0.49, RI=0.63, RC=0.31), inferred from 28S rDNA sequence data with Pezizales as outgroup taxa.

Species typica*. Cyanoannulus petersenii* Raja, J. Campb., *et* Shearer sp. nov.

Etymology: From the Greek *cyano-* = dark blue and the Latin *annulus* = ring, referring to the dark blue staining reaction of the apical ring when treated with aqueous cotton blue or aqueous nigrosin.

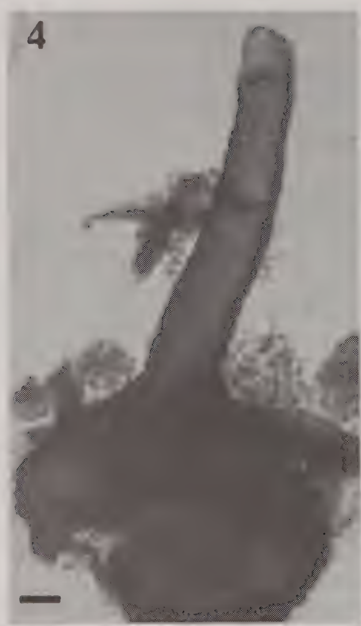
Cyanoannulus petersenii Raja, J. Campb. *et* Shearer sp. nov. Figs. 4–18

Ascomata dispersa, immersa ad partim immersa, leviter horizontalia, pallida rubra brunnea, 405–800 × 214–297 µm; venter globosus ad subglobosas (Figs. 4 & 5). Peridium e *textura angularis* in facei (Fig. 6), longitudinem bistratum: stratum interior hyalinum pseudoparenchyma 9–14 × 3–4 µm; stratum exterior e cellulae parium fuscatorum 6–10 × 2–9 µm (Fig. 7). Collum centrale, longum, cylindracum, angustatum distale, pallidum rubrum brunneum (Figs. 4 & 8), 340–760 × 25–65 µm, periphysium. Hamathecium paraphysibus, paraphyses septata, 9–12 µm latae ad basem, angustata distales, 55–110 µm longae (Fig. 9). Asci unitunicati, fusoidi, octospori, 73–142 × 8–12 µm (n=25), cum apparatu apicali bipartis et cylindrico, ca. 2–3 × 4–5 µm, non amyloideus, labis caerulei poirreri aquosi ope caerulescentum (Figs. 10 & 11). Ascosporae crassiparibus, hyalinae, fusiformes, in unum latus complanatae, imbricatae uniseriatae, triseptatae, constrictae ad septa, septa crassa, canali angustus ad apices (Fig. 14), unigutta grandis in cellula centralem et guttae parvae in cellulas terminals (Fig. 15), 20–26.5 × 5–7 µm (mean = 23.5 × 6.3, SD =1.8 × 0.66, n =50), circumcinctus a vagina muscilagina (Figs. 16-18).

Ascomata scattered, immersed to partially immersed, slightly horizontal to the substrate surface, pale reddish brown, 405–800 × 214–297 µm; venter globose to subglobose (Figs. 4 & 5). *Peridium of textura angularis* in face view (Fig. 6), in longitudinal section comprised of two regions: inner region of 2–3 layers of hyaline, thin-walled, elongated pseudoparenchymatic cells 9–14 × 3–4 µm; outer region of 5–6 layers of dark-walled cells 6–10 × 2–9 µm (Fig. 7). *Neck* central, long, cylindrical, tapering slightly at the apex, pale reddish brown, lighter color towards the apex (Figs. 4 & 8), 340–760 × 25–65 µm, periphysate. *Hamathecium* of hyaline, septate paraphyses, constricted at the septa, 9–12 µm broad at the base, 6– 8 µm wide at the midpoint, tapering distally, 55–110 µm long (Fig. 9). *Asci* unitunicate, fusoid, 8-spored, 73–142 × 8–12 µm (n =25), separating from the hymenial layer at maturity, with a bipartite cylindrical apical apparatus ca. 2–3 × 4–5 µm, non-amyloid, staining blue with aqueous cotton blue and aqueous nigrosin, apical body attached below apical apparatus staining blue with aqueous nigrosin (Figs. 10 & 11). *Ascospores* thick-walled, hyaline, fusiform, flattened on one side, overlapping uniseriate, three-septate, constricted at the septa, septa thick, with a narrow channel at the apices (Fig. 14), containing a single large lipid globule in each central cell and smaller lipid globules in each end cell, (Fig. 15) 20–26.5 × 5–7 µm (mean= 23.5 × 6.3, SD = 1.8 × 0.66, n=50), surrounded by an ephemeral mucilaginous sheath extending 3–5 µm from the ascospore at the widest part (Figs. 16–18).

Etymology: Named in honor of Dr. R. H. Petersen for his early work on aquatic hyphomycetes in the Great Smoky Mountains National Park.

Habitat: Saprobic on submerged wood in fresh water streams.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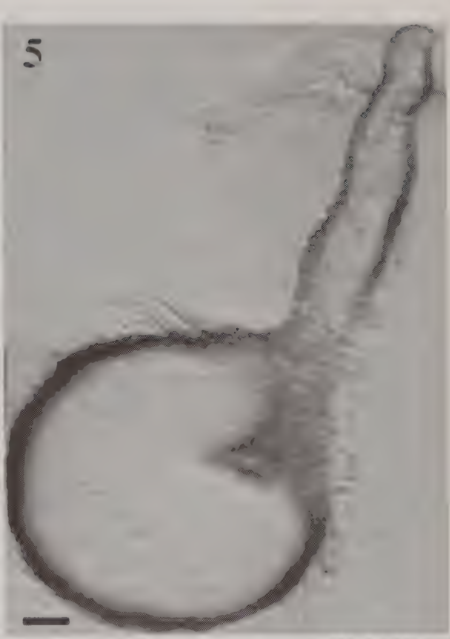
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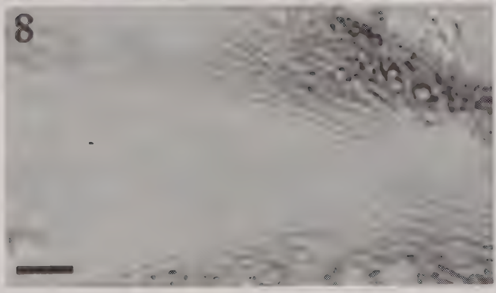
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Holotype: USA, NORTH CAROLINA: Great Smoky Mountains National Park, Oconaluftee River, 35°34.201'N, 83°20.123'W, UTM Zone 290731 mE, 3936678 mN, water temperature 20 C, pH 5, on submerged, decorticated wood, 3 July, 2002, *Huzefa A. Raja & Nate Hamburger* R044-1. (ILL)

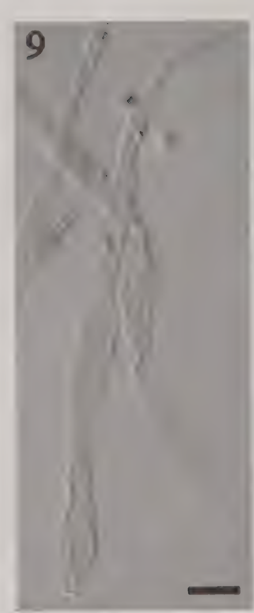
Additional specimens examined: USA. TENNESSEE: Great Smoky Mountains National Park, Walker Camp Prong, 35°37.464'N, 83°26.300'W, water temperature 10 C, pH 5, on submerged decorticated wood, 20 July 2000, *Jinx Campbell* R044-2; Middle Prong of the Little River, 35°37.469'N, 83°40.913'W, water temperature 22 C, pH 5, on submerged decorticated wood, 5 July 2002, *Huzefa A. Raja & Nate Hamburger* R044-3; Rock Creek, 35°45.679'N, 83°12.643'W, water temperature 22 C, pH 5, on submerged decorticated wood, 6 July 2002, *Huzefa A. Raja & Nate Hamburger* R044-4. COSTA RICA, Heredia, La Selva Biological Station, Sura 60, small freshwater stream, 10°25'48"N, 84°1'32"W, UTM Zone 16, 825685 mE, 1154486 mN, water temperature 25 C, pH 5, on submerged decorticated wood, 18 May, 2000, *Jennifer L. Anderson & Rebecca Wulffen* A497-1; Sura 100, small freshwater stream, on submerged wood, 6 February 2001, *Cathy M. Pringle* A497-2; Piper, small freshwater stream, on submerged, partially decorticated wood, 6 February, 2001, *Cathy M. Pringle* A497-3.

Geographical Distribution. North America (NC, TN), Costa Rica.

DISCUSSION

When the genus *Clohiesia* was established for *C. corticola*, Hyde (1995) discussed the difficulties in placing this taxon at the familial level. Suggested families included the Clypeosphaeriaceae, Lasiosphaeriaceae and Annulatascaceae. Tsui *et al.* (1998) determined, with the description of a new species, *C. lignicola* C.K.M. Tsui *et al.*, that *Clohiesia* belongs in the Annulatascaceae based on the "relatively massive apical ring" (2 x 3–4 µm in *C. lignicola*), the fusoid to cylindrical asci and the single celled ascospores surrounded by a sheath. Features in conflict with those of the Annulatascaceae include presence of a clypeus, and a relatively short neck. Molecular evidence presented herein (Fig. 1) indicates that the genus *Clohiesia* does not belong in the Annulatascaceae.The monophyly of the genus *Annulatascus* is not supported (Fig. 2). The type species of the genus, *A. velatisporus,* is placed on a clade with *A. hongkongensis* (Fig. 2, clade C) and this clade is considered *Annulatascus sensu stricto*. Two other species of *Annulatascus*, *A. triseptatus* and *A. biatriisporus*, are separated from each other and from *Annulatascus sensu stricto* (Fig. 2, clades B, C & D). This genus requires further molecular and morphological study and the nomenclature will be dealt with when other species of *Annulatascus* become available.

Figure 4-8 *Cyanoannulus petersenii*. 4. Whole mount of ascoma (measure bar = 40 µm). 5. Longitudinal section of ascoma (measure bar = 40 µm). 6. Tissue of peridium in face view, *textura angularis*. (measure bar = 10 µm). 7. Longitudinal section of the ascomal wall. 8. Longitudinal section through the ascomal neck showing periphyses (measure bar = 10 µm).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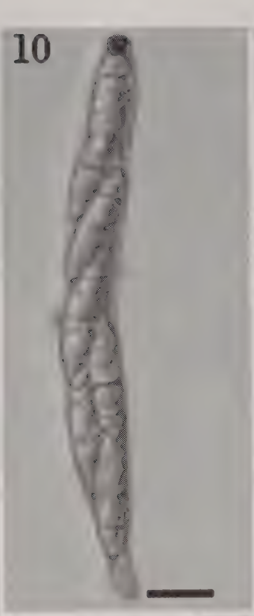
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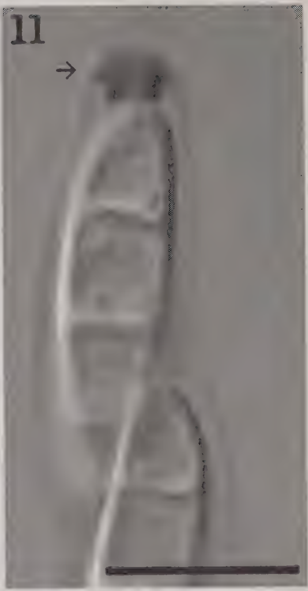
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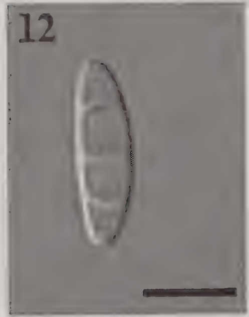
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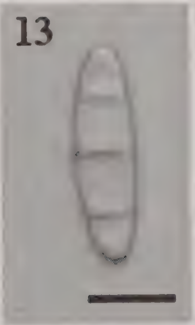
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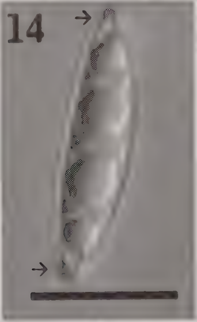
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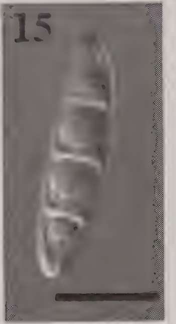
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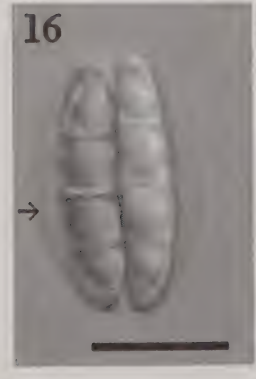
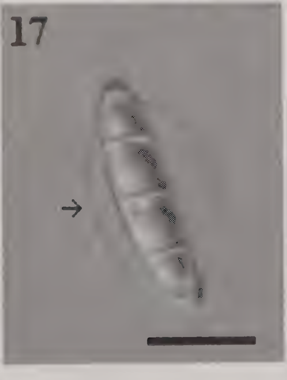
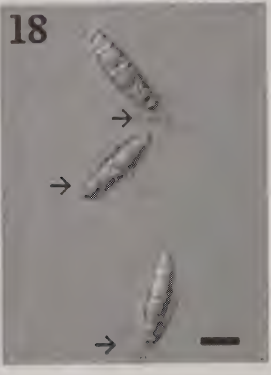

16


17


18

Isolates a and b of *Cyanoannulus petersenii* (R044-1) are placed on a clade with *Annulatascus biatriisporus*. However, this clade has no significant bootstrap support, posterior probability or decay index, and collapses in all consensus trees, indicating that the phylogenetic affinities between the two species are insignificant. When *A. biatriisporus* is removed from the analysis (data not shown) *C. petersenii* is placed on a monophyletic clade. It shows no significant phylogenetic affinities with any other genus of the Annulatascaceae. Based on morphological distinctiveness from other genera in the Annulatascaceae and molecular data (Figs. 1 & 2), a new genus, *Cyanoannulus*, is established. The distinguishing combination of morphological characteristics that defines this genus include: pale reddish brown ascomata, two-layered peridium with cells darkened toward the outside, fusoid asci with a large, bipartite apical ring that stains in aqueous cotton blue, and thick-walled ascospores with channels in their apical walls, and presence or absence of a gelatinous sheath.

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LITERATURE CITED

Bremer, K. 1988. The limits of amino acid sequence data in angiosperm phylogenetic reconstruction. Evolution 42: 795-803.

Bremer, K. 1994. Branch support and tree stability. Cladistics 10: 295-304.

Bunyard, B.A., Nicholson, M.S., and Royse, D.J. 1994. A systematic assessment of *Morchella* using RFLP analysis of the 28S rRNA gene. Mycologia 86: 762-772.

Campbell, J. 1999. Molecular phylogeny of the Halosphaeriaceae. (PhD Dissertation) Portsmouth, UK: University of Portsmouth. 217 p.

Campbell, J., Anderson J.L., and Shearer, CA. 2003a. Systematics of *Halosarpheia* based on morphological and molecular data. Mycologia 95: in press.

Figures 9–18. *Cyanoannulus petersenii*. (Measure bars = 10 μm). 9. Paraphyses. 10. Ascus with mature ascospores. 11. Ascus with bipartite apical ring. 12-15. Mature ascospores. 12-13. Ascospores in glycerine, note the thick walls. 14. Ascospore in distilled water, note arrow showing the narrow channel at the ascospore apices. 15. Ascospore with constricted septa. 16-18. Ascospores with gelatinous sheath. 16. Two ascospores joined by an oval sticky gelatinous sheath in aqueous nigrosin. 17. Ascospore with oval mucilaginous sheath in aqueous nigrosin. 18. Ascospores with dissolving sheath.

Campbell, J., Shearer, C.A., Crane, J.L., and Fallah, P.M. 2003b. A reassessment of two freshwater ascomycetes, *Ceriospora caudae-suis* and *Submersisphaeria aquatica*. Mycologia 95: 41-53.

Darlu, P., and Tassey, P. 1987. Roots (a comment on the evolution of human mitochondrial DNA and the origins of modern humans). Human evolution 2: 407-412.

Eriksson, T. 1998. AutoDecay. ver 4.0. Stockholm: Department of Botany, Stockholm University.

Fallah, P.M., and Shearer, C.A. 2001. Freshwater ascomycetes: new or noteworthy species from north temperate lakes in Wisconsin. Mycologia 93: 566-602.

Farris, J.S. 1982. Outgroups and parsimony. Systematic Zoology 31: 328-334.

Ho, W.W.H., Tsui, C.K.M., Hodgkiss, I.J., and Hyde, K.D. 1999. *Aquaticola*, a new genus of Annulatascaceae from freshwater habitats. Fungal Diversity 3: 87-97.

Huelsenbeck, J.P., and Ronquist, F. 2001. MRBAYES: Bayesian inference of phylogenetic trees. Bioinformatics 17: 754-755.

Huhndorf, S.M. 1991. A method of sectioning ascomycete herbarium specimens for light microscopy. Mycologia 83: 520-524.

Hyde, K.D. 1992. Tropical Australian Freshwater Fungi. II. *Annulatascus velatispora* gen. et sp. nov., *A. bipolaris* sp. nov. and *Nais aquatica* sp. nov. (Ascomycetes). Australian Systematic Botany 5: 109-116.

Hyde, K.D. 1995. Tropical Australian freshwater fungi. VII. New genera and species of Ascomycetes. Nova Hedwigia 61: 119-140.

Hyde, K.D., Wong, S.W., and Jones, E.B.G. 1999. *Cataractispora* gen. nov. with three new freshwater lignicolous species. Mycological Research 103: 1019-1031.

Kishino, H., and Hasegawa, M. 1989. Evaluation of the maximum likelihood estimate of the evolutionary tree topologies from DNA sequence data, and the branching order of Hominoidea. Journal of Molecular Evolution 29: 170-179.

Maddison, W.P., Donoghue, M.J., and Maddison, D.R. 1984. Outgroup analysis and parsimony. Systematic Zoology 33: 83-103.

Maddison, W.P., and Maddison, D.R. 1992. MacClade: analysis of phylogeny and character evolution. ver. 3.08a. Sunderland, Massachusetts: Sinauer Associates.

Qiagen. 2000. DNeasy^{TM} plant mini kit handbook. USA: QIAGEN Inc.

Qiagen. 2001. QIAquick spin handbook for QIAquick PCR purification kit. USA: QIAGEN Inc.

Rambaut, A. 2001. Se-Al: Sequence Alignment Editor. ver. 2.0a9. UK: University of Oxford.

Rannala, B., and Yang, Z. 1996. Probability distribution of molecular evolutionary trees: a new method of phylogenetic inference. Journal of Molecular Evolution 43: 304-311.

Ranghoo, V.M., and Hyde, K.D. 1998. Ascomycetes from freshwater habitats: *Ascolacicola aquatica* gen. et sp. nov. and a new species of *Ascotaiwania* from wood submerged in a reservoir in Hong Kong. Mycologia 90: 1055-1062.

Ranghoo, V.M., Hyde, K.D., Liew, E.C.Y., and Spatafora, J.W. 1999. Family placement of *Ascotaiwania* and *Ascolacicola* based on DNA sequence from large subunit rRNA gene. Fungal Diversity 2: 159-168.

Ranghoo, V.M., Tsui, C.K.M., and Hyde, K.D. 2001. *Brunneosporella aquatica* gen. et sp. nov., *Aqualignicola hyalina* gen. et sp. nov., *Jobellisia viridifusca* sp. nov.and *Porosphaerellopsis bipolaris* sp. nov. (ascomycetes) from submerged wood in freshwater habitats. Mycological Research 105: 625-633.

Rodriguez, F., Oliver, J., Marin, A., and Medina, J. 1990. The general stochastic model of nucleotide substitution. Journal of Theoretical Biology 142: 485-502.

Shearer, C.A. 1993. The freshwater ascomycetes. Nova Hedwigia 56: 1-33.

Spatafora, J.W., Volkmann-Kohlmeyer, B., and Kohlmeyer, J. 1998. Independent terrestrial origins of the Halosphaeriales (marine Ascomycota). American Journal of Botany. 85: 1569-1580.

Stevens, P.F. 1980. Evolutionary polarity of character states. Annual Review of Ecology and Systematics 11: 333-358.

Swofford, D.L. 2002. PAUP*. Phylogenetic Analysis Using Parsimony (*and Other Methods). ver 4. Sunderland, Massachusetts: Sinauer Associates.

Thompson, J.D., Gibson, T.J., Plewniak, F., Jeanmougin, F., and Higgins, D.G. 1997. The Clustal-X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Research 25: 4876-4882.

Tsui. C.K.M., Hyde, K.D., and Hodgkiss, I.J. 1998. A new species of *Clohiesia* from Hong Kong. Mycosciecne 39: 257-259.

Vilgalys, R., and Hester, M. 1990. Rapid genetic identification and mapping of enzymatically amplified ribosomal DNA from several *Cryptococcus* species. Journal of Bacteriology 172: 4238-4246.

Volkmann-Kohlmeyer, B., and Kohlmeyer, J. 1996. How to prepare truly permanent microscopic slides. Mycologist 10: 107-108.

Watrous, L.E., and Wheeler, Q.D. 1981. The outgroup comparison method of character analysis. Systematic Zoology 30: 1-11.

Wong, S.W., Hyde, K.D., and Jones, E.B.G. 1998. Annulatascaceae, a new ascomycete family from the tropics. Systema Ascomycetum 16: 17-25.

Zhazybayeva, O., and Gogarten, J.P. 2002. Bootstrap, Bayesian probability and maximum likelihood mapping: exploring new tools for comparitive genome analyses. Genome 3.

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ANNOTATED BASIC REFERENCES OF NOVEL FUNGAL TAXA INTRODUCED FROM THE MIDDLE EAST (1940-2000)

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ABSTRACT: Basic descriptive taxonomic references are documented for fungi new to science introduced over the years 1940-2000 from various localities of the Middle East. The 186 relevant titles are listed in alphabetic order of the authors' names. These titles convey the protologues of 254 taxonomic units at the species and infraspecific levels. Each title is annotated with the name(s) of the proposed fungus and the country of origin. Cases (and reasons) of invalid publication are then stated, in addition to known changes in taxonomic positions. This regional database is expected to stimulate taxonomic research on the mycobiota of the arid Middle East.

KEYWORDS: taxonomy, bibliography, documentation, protologues, biogeography

INTRODUCTION

Interest in the mycobiota of the arid Middle East has led to the proposal of several taxa new to science. The protologues to these fungi were commonly elaborated by taxonomists active in institutions located outside the region, occasionally by local mycologists, and less so through collaboration of local and external workers (Mouchacca 1995). The relevant literature is scattered through a wide array of journals and books, some of which also proved difficult to obtain (Mouchacca 1999).

As yet, there is no comprehensive annotated list of fungi for the states of the Middle East. Partial surveys of plant-pathogenic fungi have been respectively compiled for few countries (Johnston & Booth 1983) but these lists require a thorough revision and updating. Similar documents relating to saprobic fungi have been produced for Egypt (El-Abyad 1997), Kuwait (Al-Musallam 1987, Moustafa 1986) and Lybia (El-Buni & Rattan 1981). The first attempt to summarize information on the Middle East level is due to Moubasher (1993). He provided descriptions of nearly 230 taxa, mainly isolated from Qatari and Egyptian soils. However, simply eight novel fungi originating from this arid zone were reported in this global document.

The present annotated basic references is an addition to previous work undertaken on the topic (Mouchacca 2001 a & b). It brings together bibliographic titles of novel fungi having original localities situated in the Middle East. The conveyed protologues deal with fungi described from the beginning of the Second World War and terminate at the end of the 20th Century. The database is implemented with available information on the status of introduced binomials synthesized in previous publications (Mouchacca 1995, 1999 & in press). Its availability should enhance our knowledge of, and stimulate research into, the taxonomy and biology of the fungi of the arid Middle East region.

LIST OF ANNOTATED TITLES

Basic taxonomic references were first arranged in an alphabetic order of authors' names. They were then sequentially numbered for cross indexing with the accompanying list of introduced fungi reported following the original names. In this global list taxa described were grouped on the basis of systematic characters at the Class levels.

The 186 titles treated introduce 254 taxonomic units at the species and sub-species levels. Each title is annotated with the new fungal name(s) and the country of origin of the holotype. Further information provided refer to cases of invalid publication - commonly due to the absence of a Latin diagnosis or lacking specification for type material - designated following specific articles of the International Code of Botanical Nomenclature 'ICBN' (Greuter *et al.* 2000). Changes in taxonomic positions (synonymies or generic transfer) are also specified. The relevant data were extracted from previously published notes on the taxonomic status of these Middle East fungi (Mouchacca 1995, 1999 & in press). Finally fungal author's names are abbreviated following Kirk & Ansell (1992).

1 - ABDULLAH S.K., 1987. Additions to coprophilous fungi of Iraq. I - A new species of *Podospora*. Nova Hedwigia 44: 345-347. *Podospora euphratica* Abdullah, Iraq.

2 - ABDULLAH S.K., 1993. New and noteworthy ascomycetes from Iraq. Transactions of the British Mycological Society 81: 392-396. *Strattonia mesopotamica* Abdullah, Iraq.

3 - ABDULLAH S.K. & ABBAS B.A., 1994. *Sphaerodes iraquiensis* sp. nov., a new ascomycete from surface sediment of the Shatt Al-Arab river. Iraq. Marina Mesopotamica 9: 205-208. *Sphaerodes iraquiensis* Abdullah & Abbas, Iraq.

4 - ABDULLAH S.K. & AL-BADER S.M., 1989. A new thermotolerant species of *Chaetomium* from Iraqi forest soil. International Journal of Mycology and Lichenology 4: 83-91. *Chaetomium subcurvisporum* Abdullah & Al-Bader, Iraq.

5 - ABDULLAH S.K. & AL-BADER S.M., 1992. *Thielavia minuta* (Cain) Malloch & Cain var. *thermophila* Abdullah & Al-Bader var. nov. from Iraqi forest soil. Basrah Journal of Agricultural Research 5: 115-120. *Thielavia minuta* (Cain) Malloch & Cain var. *thermophila* Abdullah & Al-Bader: now *Melanocarpus thermophilus* (Abdullah & Al-Bader) Guarro, Abdullah & Al-Bader, Iraq.

6 - ABDULLAH S.K. & AL-SAADOON A.H., 1994. *Syspastospora tetraspora* sp. nov., a new ascomycete from the Khawr Al-Zubair estuary, Southern Iraq. Marina Mesopotamica 9: 83-89. *Syspastospora tetraspora* Abdullah & Al-Saadoon, Iraq.

7 - ABDULLAH S.K. & AL-SAADOON A.H., 1994. *Arxiomyces zubairiensis* sp. nov. from the Khawr Al-Zubair estuary, Southern Iraq. Marina Mesopotamica 9: 245-250. *Arxiomyces zubairiensis* Abdullah & Al-Saadoon, Iraq.

8 - ABDULLAH S.K., AL-SAADOON A.H. & GUARRO J., 1999. New and interesting coprophilous ascomycetes from Iraq. Nova Hedwigia 69: 211-216. *Preussia variospora* Abdullah, Al-Saadoon & Guarro, Iraq.

9 - ABDULLAH S.K., ISMAIL A.L.S. & RATTAN S.S., 1977. New and interesting coprophilous fungi from Iraq. Nova Hedwigia 28: 241-250. *Iodophanus basraneous* Abdullah, Ismail & S.S. Rattan, Iraq.

10 - ABDULLAH S.K. & ZORA S.E., 1993. *Chaetomium mesopotamicum*, a new thermophilic species from Iraqi soils. Cryptogamic Botany 3: 387-389. *Chaetomium mesopotamicum* Abdullah & Zora, Iraq.

11 - AHRENS C., 1971. Eine neue *Pythium*-Art aus dem Libanon. Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz 78: 175-180. *Pythium orthogonon* Ahrens, Lebanon.

12 - AL-MUSSALLAM A. & TAN C.S., 1989. *Chrysosporium zonatum*, a new keratinophilic fungus. Persoonia 14: 67-71. *Chrysosporium zonatum* Al-Mussallam & C.S. Tan, Kuwait.

13 - ANIKSTER J., 1987. Occurrence of *Uromyces scillarum* on the Amaryllidaceae. Transactions of the British Mycological Society 89: 327-331. *Uromyces scillarum* (Baxter) Winter forma specialis *pancratii* J. Anikster, Israël.

14 - ANIKSTER J. & WAHL I., 1966. Quatre espèces nouvelles d'*Uromyces* récoltées en Israël sur orges sauvages et sur Liliaciées. Bulletin Trimestriel de la Société Mycologique de France 82: 546-560. *Uromyces oliveirae* J. Anikster & I. Wahl, *U. raysii* J. Anikster & I. Wahl, *U. reichertii* J. Anikster & I. Wahl and *U. viennot-bourginii* J. Anikster & I. Wahl; all from Israël.

15 - ANIKSTER J. & WAHL I., 1966. *Uromyces* rusts on Barley in Israël. Israël Journal of Botany 15: 91-105. *Uromyces christensenii* J. Anikster & I. Wahl, Israël.

16 - ARX J.A. von, 1973. The genera *Petriellidium* and *Pithoascus* (Microascaceae). Persoonia 7: 367-375. *Petriellidium desertorum* Arx & Mustafa: now *Pseudallescheria desertorum* (Arx & Mustafa) Mac Ginnis *et al.*, Kuwait.

17 - ARX J.A. von, GUARRO J. & FIGUERAS M.J., 1986. The Ascomycete genus *Chaetomium*. Beihefte zür Nova Hedwigia 84: 1-162. *Chaetomium dreyfussii* Arx and *Ch. oblatum* Dreyfuss & Arx; both from Israël.

18 - AUE R. & MÜLLER E., 1967. Vergleichende Untersuchungen an einigen Chaetomiumarten. Berichte der Schweizerischen Botanischen Gesellschaft 77: 187-207. *Chaetomium gelasinosporum* Aue & E. Müll. and *Ch. uniporum* Aue & E. Müll.; both from Egypt.

19 - AUE R., MÜLLER E. & STOLL Ch. , 1969. *Pseudophaeotrichum sudanense* nov. gen. et nov. spec. Nova Hedwigia 17: 83-91. *Pseudophaeotrichum sudanense* gen. nov. & sp. nov. Aue, E. Müll. & Stoll, The Sudan.

20 - AVIZOHAR-HERSHENZON Z., 1961. On the agaricus *Xanthodermus* group in Israël. Bulletin Research Council of Israël, Sect. D, Botany 10: 171-178. *Agaricus meleagris* (Schaeff.) Pilát var. *fibrillosus* Aviz.-Hersh.: *nom. inval.*, Art. 36.1 ICBN, Israël.

21 - AVIZOHAR-HERSHENZON Z. & BINYAMINI A., 1972. Boletaceae of Israël. I. *Boletus* sect. *Luridi*. Transactions of the British Mycological Society 59: 25-30. *Boletus reichertii* Aviz.-Hersh. & Binyam., Israël.

22 - BAGHDADI V.Ch., 1968. *De speciebus novis Penicilli* Fr. *et Aspergilli* Fr. *e terris Syriae isolatis notula.* Novosti Sistematiki Vysshikh i nizshikh Rastenii 1968: 96-114. *Aspergillus kassunensis* Baghd.: a later synonym of *A. subsessilis* Raper & Fennell, Syria.
Penicillium arabicum Baghd.: a later synonym of *P. decumbens* Thom, *P. baradicum* Baghd.: a later synonym of *P. steckii* Zaleski, *P. damascenum* Baghd.: a later synonym of *P. westlingii* Zaleski, *P. ebenbitaricum* Baghd.: a later synonym of *P. dierckxii* Biourge, *P. es-suveidense* Baghd.: a later synonym of *P. simplicissimum* (Oudem.) Thom, *P. gorlenkoanum* Baghd.: a later synonym of *P. westlingii* Zaleski, *P. harmonense* Baghd.: a later synonym of *P. chrysogenum* Thom, *P. kabunicum* Baghd.: a later synonym of *P. moldavicum* Milko & Beliakova, *P. quercetorum* Baghd., *P. sizovae* Baghd., *P. syriacum* Baghd.: a later synonym of *P. manginii* Duché & R. Heim, *P. yarmokense* Baghd.: a later synonym of *P. cremeogriseum* Chalabuda; all from Syria.

23 - BEN-ZE'EV I. & KENNETH R.G., 1979. *Zoophthora erinacea* sp. nov. (Zygomycetes: Entomophthoraceae), a fungal parasite on Aphids. Mycotaxon 10: 219-232. *Zoophthora erinacea* Ben-Ze'ev & R.G. Kenneth: now *Erynia erinacea* (Ben-Ze'ev & R.G. Kenneth) Remaud. & Hennebert, Israël.

24 - BEN-ZE'EV I. & KENNETH R.G., 1981. *Zoophthora orientalis* sp. nov. a fungal pathogen of Aphis citricola (Homoptera: Aphididae), and two new combinations of other species of Entomophthoraceae. Phytoparasitica 9: 33-42. *Zoophthora orientalis* Ben-Ze'ev & R.G. Kenneth: now *Erynia orientalis* (Ben-Ze'ev & R.G. Kenneth) Humber, Ben-Ze'ev & R.G. Kenneth, Israël.

25 - BEN-ZE'EV I. & ZELIG Y., 1984. *Entomophthora israelensis* sp. nov. Zygomycetes: Entomophthorales], a fungal pathogen of gall midges [Diptera: Cecidomyiidi]. Mycotaxon 21: 463-474. *Entomophthora israelensis* Ben-Ze'ev & Zelig, Israël.

26 - BESADA W.H. & YUSEF H.M., 1968 (1970 ?). Some Phycomycetes and Ascomycetes newly recorded in UAR soils. Proceedings of the Egyptian Academy of Science 21: 103-109. *Chaetomium mareoticum* Besada & Yusef: *nom. inval.*, Art. 36.1 ICBN, Egypt.

27 - BESADA W.H. & YUSEF H.M., 1969. *Chaetomium mareoticum* sp. nov. Transactions of the British Mycological Society 52: 502-504. *Chaetomium mareoticum* Besada & Yusef, Egypt.

28 - BOEREMA G.H. & GRUYTER J. de, 1999. Contributions towards a monograph of *Phoma* (Coelomycetes) III - Supplement. Additional species of section *Plenodomus*. Persoonia 17: 273-280. *Phoma pimpinellae* Boerema & Gruyter, Israël.

29 - BRUMMELEN J. van, 1976. Some new species of *Saccobolus*. Persoonia 8: 421-430. *Saccobolus parvisporus* Brumm. and *S. purpureus* Brumm.; both from Lybia.

30 - BUCHALO A.S., NEVO E., WASSER S.P., OREN A. & MOLITORIS H.P., 1998. Fungal life in the extremely hypersaline water of the Dead Sea: first records. Proceedings of the Royal Society, London B 265: 1461-1465. *Gymnascella marismortui* Buchalo *et al.*, Israël.

31 - CAMPBELL C.K. & AL-HEDAITHY S.S.A., 1993. Phaeohyphomycosis of the brain caused by *Ramichloridium mackenziei* sp. nov. in Middle Eastern Countries. Journal of Medical and Veterinary Mycology 31: 325-332. *Ramichloridium mackenziei* C.K. Campb. & Al-Hedaithy, Saudi Arabia.

32 - CANNON P.F., 1996. Systematics and diversity of the Phyllachoraceae associated with Rosaceae, with a monograph of *Polystigma*. Mycological Research 100: 1409-1427. *Polystigma amygdalinum* P.F. Cannon, Israël.

33 - CANNON P.F., ABDULLAH S.K. & ABBAS B.A., 1995. Two new species of *Monascus* from Iraq, with a key to known species of the genus. Mycological Research 99: 659-662. *Monascus pallens* P.F. Cannon, Abdullah & Abbas and *M. sanguineus* P.F. Cannon, Abdullah & Abbas; both from Iraq.

34 - CANO J., GUARRO J. & EL-SHAFIE A.E., 1993. A new *Chaetomidium* from Oman. Mycotaxon 49: 399-403. *Chaetomidium khodense* Cano, Guarro & El Shafie, Oman.

35 - CHABELSKA-FRYDMAN C., 1964. A new species of *Fusariella* from Israël. Canadian Journal of Botany 42: 1485-1487. *Fusariella huguesii* Chab.-Fryd., Israël.

36 - CHORIN M., 1960. Powdery mildew on leaves of groundnuts. Bulletin Research Council of Israël, Sect. D, Botany 7: 148-149. *Oidium arachidis* Chorin: *nom. inval.*, Art. 37.1 ICBN, Israël.

37 - CUMMINS G.B., 1956. Descriptions of Tropical Rusts - VIII. Bulletin of the Torrey botanical Club 83: 221-233. *Phakospora setariae* Cummins, The Sudan.

38 - DEIGHTON F.C., 1959. Studies on *Cercospora* and allied genera. I. *Cercospora* species with coloured spores on *Phyllanthus* (Euphorbiaceae). Mycological Papers 71: 1-23. *Cercospora tarrii* Deighton, The Sudan.

39 - DEIGHTON F.C., 1974. Studies on *Cercospora* and allied genera. V. *Mycovellosiella* Rangel, and a new species of *Ramulariopsis*. Mycological Papers 137: 1-75. *Mycovellosiella tarrii* Deighton: now *Passalora tarrii* (Deighton) U. Braun & Crous, The Sudan.

40 - DEIGHTON F.C., 1979. Studies on *Cercospora* and allied genera. VII. New species and redispositions. Mycological Papers 144: 1-56. *Phaeoramularia sudanensis* Deighton: now *Passalora sudanensis* (Deighton) U. Braun & Crous, The Sudan.

41 - DRING D.M. & RAYSS T., 1963 (1964). The Gasteromycete Fungi of Israël. Israël Journal of Botany 12: 147-178. *Scleroderma multiloculare* Dring & Rayss, Israël.

42- EL-HILALY A.F., ELAROSI H., ASSAWAH M.W. & KILANI A., 1962. Studies on fungi associated with onion crop in the field and during storage. Phytopathologia Mediterranea 2: 37-45. *Botrytis septospora* El-Helaly *et al.*: *nom. inval.*, Art. 36.1 ICBN, Egypt.

43 - ELLIS M.B., 1959. *Clasterosporium* and some allied dematiaceae-phragmosporae. II. Mycological Papers 72: 1-75. *Stigmina beshirii* M.B. Ellis: now *Scolecostigmina beshirii* (M.B. Ellis) U. Braun and *Stigmina sudanensis* M.B. Ellis: now *Scolecostigmina sudanensis* (M.B. Ellis) U. Braun; both from The Sudan.

44 - EL-MASRY H.G. & ZSOLT J., 1966. *Geotrichum novakii* n. sp. Acta Biologica (Szeged, Hungary), N.S. 12: 67-70. *Geotrichum novakii* El-Masry & Zsolt: a later synonym of *Geotrichum candidum* Link : Fr., Egypt.

45 - EL-SHAFIE A.E., 1980. *Drechslera gedarefensis* n. sp. from Sorghum grains. Transactions of the British Mycological Society 74: 437-438. *Drechslera gedarefensis* El Shafie: now *Exserohilum gedarefense* (El Shafie) Alcorn, The Sudan.

46 - EL-SHAFIE A.E. & WEBSTER J., 1981. *Setosphaeria khartoumensis* sp. nov. and its *Exserohilum* conidial state. Transactions of the British Mycological Society 77: 442-446. *Setosphaeria khartoumensis* El Shafie & J. Webster, The Sudan.

47 - ESSLINGER Th.L., 1977. A chemosystematic revision of the brown Parmeliae. The Journal of the Hattori Botanical Laboratory 45: 1-211. *Parmelia pulloides* Essl.: now *Neofuscelia pulloides* (Essl.) Essl., Israël.

48 - FELDMAN-MUHSAM B. & HAVIVI Y., 1963. On *Adlerocystis* n. gen. (Phycomycetes) a symbiote of Ornithodoros ticks. Parasitology 53: 183-188. *Adlerocystis parkeri* Feldm.-Muhs. & Havivi nov. sp., type species of *Adlerocystis* Feldm.-Muhs. & Havivi nov. gen.: *nom. inval.*, Arts. 36.1 & 37.1 ICBN and *A. ornithodori* Feldm.-Muhs. & Havivi (second species): *nom. inval.*, Arts. 36.1 & 37.1 ICBN; both from Israël.

49 - FISHER P.J. & PETRINI O., 1983. Two new pyrenomycetes from submerged wood. Transactions of the British Mycological Society 81: 396-398. *Chaetosphaeria anglica* P.J. Fisher & Petrini, The Sudan.

50 - FRISVAD J.C., SAMSON R.A., RASSING B.R., HORST M.I. van der, RIJN F.T. J. van & STARK J., 1997. *Penicillium discolor*, a new species from cheese, nuts and vegetables. Antonie van Leeuwenhoek 72: 119-126. *Penicillium discolor* Frisvad & Samson, Israël.

51 - GAERTNER A., 1954. Beschreibung dreier neuer Phlyctochytrien und eines *Rhizophydium* (Chytridiales) aus Erdboden. Archiv für Mikrobiologie 21: 112-126. *Rhizophydium racemosum* A. Gaertn., Egypt.

52 - GALUN M. & MORTON K., 1970. A new species of *Gonohymenia* from the Sinai Peninsula and its position in the genus. The Bryologist 73: 378-380. *Gonohymenia sinaica* Galun & Marton: now *Lichinella sinaica* (Galun & Marton) Moreno & Egea, Israël.

53 - GAMS W., O'DONNELL K., SCHROERS H.-J. & CHRISTENSEN M., 1998 (1999). Generic classification of some more hyphomycetes with solitary conidia borne on phialides. Canadian Journal of Botany 76: 1570-1583. *Stanjemonium fuscescens* W. Gams, Schroers & Abdullah, Iraq.

54 - GENE J., EL-SHAFIE A.E. & GUARRO J., 1993. Two new coprophilous Pezizales from the Sultanate of Oman. Mycotaxon 46: 275-284. *Coprotus dhofarensis* Gené, El Shafie & Guarro and *Thecotheus harasisus* Gené, El Shafie & Guarro; both from Oman.

55 - GIRALT M., NIMIS P.R. & POELT J., 1993. Studien über eineige arten der flechtengattung *Xanthoria* mit isidiiformen vegetativen diasporen. Journal of the Hattori Botanical Laboratory 74: 271-285. *Xanthoria stiligera* Giralt, Nimis & Poelt, Israël.

56 - GIUMA A.Y. & COOKE R.C., 1972. Some endozoic fungi parasitic on soil nematodes. Transactions of the British Mycological Society 59: 213-217. *Nematoctonus tripolitanus* Giuma & R.C. Cooke, Lybia.

57 - GUARRO J., ABDULLAH S.K., AL-SAADOON A.H. & GENE J., 1996. A new *Zopfiella* (Lasiosphaeriaceae) from Iraq. Mycotaxon 59:197-202. *Zopfiella cephalothecoidea* Guarro *et al.*, Iraq.

58 - GUARRO J., ABDULLAH S.K., GENE J. & AL-SAADOON A.H., 1997. A new species of *Preussia* from submerged plant debris. Mycological Research 101: 305-308. *Preussia aquilirostrata* Guarro *et al.*, Iraq.

59 - GUARRO J., AL-SAADOON A.H. & ABDULLAH S.K., 1997. Two new coprophilous species of *Preussia* (Ascomycetes) from Iraq. Nova Hedwigia 64: 177-183. *Preussia constricta* Guarro, Al-Saadoon & Abdullah and *P. hexophragmia* Guarro, Al-Saadoon & Abdullah; both from Iraq.

60 - GUARRO J., AL-SAADOON A.H., GENE L. & ABDULLAH S.K., 1997. Two new cleistothecial ascomycetes from Iraq. Mycologia 89: 955-961. *Corynascella arabica* Guarro *et al.* and *Zopfiella submersa* Guarro *et al.*; both from Iraq.

61 - GUARRO J., GENE L., AL-BADER S.M. & ABDULLAH S.K., 1997. A new species of *Coniochaetidium* from soil. Mycoscience 38: 123-125. *Coniochaetidium nuciforme* Guarro *et al.*, Iraq.

62 - GUIRAUD P., STEIMAN R., SEIGLE-MURANDI F. & SAGE L., 1997. *Exserohilum sodomii*, a new species isolated from soil near the Dead Sea (Israël). Antonie van Leeuwenhoek 72: 317-325. *Exserohilum sodomii* Guiraud *et al.*, Israël.

63 - HAGIWARA H., 1991. A new species and some new records of dictyostelid cellular slime mold from Oman. Bulletin of the National Science Museum Tokyo, Ser. B: Botany 17: 109-121. *Dictyostelium arabicum* H. Hagiw., Oman.

64 - HALL J.A. & SIVANESAN A., 1972. *Cochliobolus* state of *Curvularia cymbopogonis*. Transactions of the British Mycological Society 59: 314-317. *Cochliobolus cymbopogonis* J.A. Hall & Sivan., The Sudan.

65 - HANSFORD C.G., 1956. Tropical fungi - VI. New species and revisions. Sydowia 10: 41-100. *Meliola sudanensis* Hansford, The Sudan.

66 - HAWKSWORTH D.L., 1978. A new species of *Coniochaeta* with an interesting conidial state. Norwegian Journal of Botany 25: 15-18. *Coniochaeta nodulisporioides* D. Hawksw., Jordan.

67 - HENSSEN A., 1979. Problematik der Gattungsbegrenzung bei den Lichinaceen. Berichte der deutschen botanischen Gesellschaft, Berlin 92: 483-506. *Gonohymenia inflata* Henssen: now *Lichinella inflata* (Henssen) Moreno & Egea, Israël.

68 - HORIE E.Y. & UDAGAWA S.-I., 1996. *Emericella omanensis*, a new species from Oman soil. Mycoscience 36: 391-394. *Emericella omanensis* Y. Horie & Udagawa, Oman.

69 - HORIE E.Y., UDAGAWA S.-I., ABDULLAH S.K. & AL-BADER S.M., 1990. *Emericella similis*, a new species from Iraqi soil. Transactions of the Mycological Society of Japan 31: 425-430. *Emericella similis* Y. Horie *et al.*, Iraq.

70 - KARLING J.S., 1956. New and unidentified species of *Synchytrium*. Beihefte zür Sydowia, Annales Mycologici, Ser. II, I. Festschrift für FRANZ PETRAK: 132-145. *Synchytrium helianthemum* Karling, *nom. nov.* for *S. aureum* Schröt. *sensu* Rayss 1942: *nom. inval.*, Art. 36.1 ICBN, Israël.

71 - KENNETH R.G., 1964. Downy mildew of ryegrass in Israël caused by *Sclerophthora lolii* sp. nov. Israël Journal of Botany 12: 136-139. *Sclerophthora lolii* R.G. Kenneth, Israël.

72 - KENNETH R.G., 1977. *Entomophthora turbinata* sp. nov., a fungal parasite of the peach trunk aphid Pterochloroides persicae (Lachnidae). Mycotaxon 6: 381-390. *Entomophthora turbinata* R.G. Kenneth, Israël.

73 - KENNETH R.G., KOLTIN Y. & WAHL I., 1964. Barley diseases newly found in Israël. Bulletin of the Torrey botanical Club 91: 185-193. *Sclerophthora rayssiae* R.G. Kenneth *et al.*, Israël.

74 - KRUG J.C., KHAN R.S. & JENG R.S., 1994. A new species of *Gelasinospora* with multiple germ pores. Mycologia 86: 250-253. *Gelasinospora hippopotama* Krug, Khan & Jeng, Egypt.

75 - LÆSSØE T. & SPOONER B.M., 1994. *Rosellinia* and *Astrocystis* (Xylariaceae): new species and generic concepts. Kew Bulletin 49: 1-70. *Astrocystis hughesii* Læssøe & Spooner, The Sudan.

76 - LAUNDON G.F., 1963. Rust Fungi 1: On Acanthaceae. Mycological Papers 89: 1-89. *Uromyces hypoestis* Barr & Laundon, The Sudan.

77 - LING L., 1953. Taxonomic notes on the Ustilaginales III. Sydowia 7: 151-157. *Sorosporium urelytri* L. Ling: now *Sporisorium urelytri* (L. Ling) Vánky, The Sudan.

78 - LOCQUIN-LINARD M., 1980. *Achaetomium crystalliferum* Faurel & Locquin-Linard. Nouvelle espèce d'Ascomycète (ACHAETOMIACEAE) isolée d'un sol aride. Cryptogamie, Mycologie 1: 235-240. *Achaetomium cristalliferum* Faurel & Locq.-Lin.: a later synonym of *A. strumarium* J.N. Rai, J.P. Tewari & K.G. Mukerji, Egypt.

79 - LOWEN R. & SIVANESAN A., 1989. *Leptosophaeria pimpinellae* and its *Phoma* anamorph. Mycotaxon 35: 205-210. *Leptosphaeria pimpinellae* Lowen & Sivan., Israël.

80 - LUNDQVIST N., 1969. *Zygopleurage* and *Zygospermella* (Sordariaceae *s. lat.*, Pyrenomycetes). Botaniska Notiser 122: 353-374. *Zygopleurage faiyumensis* N. Lundq., Egypt.

81 - LUNDQVIST N., 1970. New Podosporae (Sordariaceae *s. lat.*, Pyrenomycetes). Svensk Botanisk Tidskrift 64: 409-420. *Podospora aegyptiaca* N. Lundq., Egypt.

82 - LUNDQVIST N., 1974. *Studia fungorum fimi* II. New records of *Arnia*, and a new species, *A. bellum*. Svensk Botanisk Tidskrift 68: 289-303. *Arnium bellum* N. Lundq., Egypt.

83 - LUNGHINI D., 1979. *Cylindrotrichum gorii*, una nuova specie di ifale demaziaceo. Micologia Italiana 8: 25-29. *Cylindrotrichum gorii* Lunghini, Jordan.

84 - MAGED S.A., GHANEM E.H. & REFFAAT B.M., 1992. Isolation of a new yeast species from an old Pharonic tomb. *In* Razak A.A. (Ed.) Second Regional Mycological Conference Abstracts, University of Al-Azhar, Cairo, Egypt, 7-10 October 1992: 14. *Trichosporon pharaoni* Maged, Ghanem & Reffaat Egypt [as *pharoni*]: *nom. inval.*, Arts. 36.1, 37.1, 37.4 & 37.5 ICBN, Egypt.

85 - MARTON K. & GALUN M., 1974. A new species of *Heppia* from the Arava valley, Israël. The Bryologist 77: 239-241. *Heppia echinulata* Marton & Galun, Israël.

86 - MARTON K. & GALUN M., 1981 (1982). The cyanophilous lichen population of the Arava valley and the Judean desert. Israël Journal of Botany 30: 125-155. *Heppia paulina* Marton & Galun, Israël.

87 - MOHAMMED M.S., AL-NAMLAH S.A. & VAUGHAN A.Q., 1987. Leaf blight of *Cassia grandiflora* DC. Indian Journal of Botany 10: 149-151. *Cercospora saudii* Mohammed, Saudi Arabia.

88 - MONOD M. & FISCHER P.J., 1983. *Plagiosphaera nilotica* sp. nov., a member of the Diaporthales from Sudan. Transactions of the British Mycological Society 81: 177-179. *Plagiosphaera nilotica* M. Monod & P.J. Fisher, The Sudan.

89 - MORSY A. El-Aziz, 1969. Fungus from the genus *Macrosporium* Fr. attacks Cotton in U.A.R. Agricultural Research Review, Cairo 47: 162-164. *Macrosporium* *macrosporum* (Zimm.) Morsy [as *macrospora*]: invalid combination for *Alternaria macrospora* Zimm., Art. 33.2 ICBN, Egypt.

90 - MOSER M., BINYAMINI N. & AVIZOHAR-HERSHENZON Z., 1977. New and noteworthy Russulales from Israël. Transactions of the British Mycological Society 68: 371-377. *Macowanites galileënsis* M. Moser, Binyam. & Aviz.-Hersh. and *Russula carmelensis* M. Moser, Binyam. & Aviz.-Hersh.; both from Israël.

91 - MOUBASHER A.H. & ABDEL-HAFEZ S. I., 1977. *Ulocladium microsporum* sp. nov. Transactions of the British Mycological Society 69: 164-166. *Ulocladium microsporum* Moub. & Abdel-Hafez: a later synonym of *Embellisia didymospora* Munt.-Cvetk, Egypt.

92 - MOUBASHER A.H. & MOUSTAFA A.F., 1972. *Aspergillus egyptiacus* sp. nov. Egyptian Journal of Botany 15: 153-154. *Aspergillus egyptiacus* Moub. & Mustafa, Egypt.

93 - MOUBASHER A.H., MAZEN M.B. & ABDEL-HAFEZ A.I., 1979. *Humicola hyalothermophila* sp. nov. Transactions of the British Mycological Society 72: 509-510. *Humicola hyalothermophila* Moub., Mazen & Abdel-Hafez, Jordan.

94 - MOUCHACCA J., 1971. Une nouvelle espèce du genre *Ulocladium*. Revue de Mycologie, Paris 36: 114-132. *Ulocladium chlamydosporum* Mouch.: now *Alternaria mouchaccae* E.G. Simmons *nom. nov.*, Egypt.

95 - MOUCHACCA J., 1971. *Pseudoeurotium desertorum* sp. nov. Revue de Mycologie, Paris 36: 123-127. *Pseudeurotium desertorum* Mouch. [as *Pseudoeurotium*], Egypt.

96 - MOUCHACCA J., 1973. Deux *Alternaria* des sols arides d'Egypte : *A. chlamydospora* sp. nov. et *A. phragmospora* van Emden. Mycopathologia Mycologia Applicata 50: 217-225. *Alternaria chlamydospora* Mouch., Egypt.

97 - MOUCHACCA J., 1973. Les *Thielavia* des sols arides : espèces nouvelles et analyse générique. Bulletin Trimestriel de la Société Mycologique de France 89: 295-311. *Thielavia arenaria* Mouch., *T. microspora* Mouch. and *T. subthermophila* Mouch.; all from Egypt.

98 - MOUCHACCA J., 1975. Espèces nouvelles et communes de *Drechslera*, isolées de sols de régions arides. Revue de Mycologie, Paris 38: 102-108. *Drechslera subpapendorfii* Mouch.: now *Bipolaris subpapendorfii* (Mouch.) Alcorn, Egypt.

99 - MOUCHACCA J., 1975. *Podospora faurelii* sp. nov. Revue de Mycologie, Paris 38: 109-113. *Podospora. faurelii* Mouch.: a later synonym of *Zopfiella karachiensis* (S.I. Ahmed & Asad) Guarro, Egypt.

100 - MOUCHACCA J., 1977. Sur un nouveau Discomycète, *Ascobolus aegyptiacus*. In Travaux dédiès à G. VIENNOT-BOURGIN, Société Française de Phytopathologie, Paris: 263-267. *Ascobolus aegyptiacus* Mouch., Egypt.

101 - MOUCHACCA J., 1979. *Desertella*, un nouveau genre d'Hyphomycète de sols arides. Revue de Mycologie, Paris 43: 71-79. *Desertella globulifera* Mouch. gen. nov. & sp. nov., Egypt.

102 - MOUCHACCA J. & GAMS W., 1993. The hyphomycete genus *Cladorrhinum* and its teleomorph connections. Mycotaxon 68: 415-440. *Cladorrhinum bulbillosum* W. Gams & Mouch. and *C. phialophoroides* Mouch. & W. Gams; both from Egypt.

103 - MOUCHACCA J. & NICOT J., 1973. Les *Fusariella* des sols arides. Revue de Mycologie, Paris 37: 168-182. *Fusariella aegyptiaca* Mouch., Egypt.

104 - MOUSTAFA A.F., 1972. *Arachniotus desertorum* sp. nov. Transactions of the British Mycological Society 61: 392-393. *Arachniotus desertorum* Mustafa: now *Gymnoascus desertorum* (Mustafa) Arx, Egypt.

105 - MOUSTAFA A.F., 1975. A new species of *Gilmaniella* from the soil of Kuwait. Persoonia 8: 332-333. *Gilmaniella macrospora* Mustafa, Kuwait.

106 - MOUSTAFA A.F., 1976. *Thielavia kuwaitensis* sp. nov. Transactions of the British Mycological Society 66: 336-338. *Thielavia kuwaitensis* Mustafa: a later synonym of *Th. coactilis* Nicot, Kuwait.

107 - MOUSTAFA A.F., 1976. *Hyalocladium*, a new hyphomycete genus from Kuwait. Transactions of the British Mycological Society 67: 537-540. *Hyalocladium moubascherii* Mustafa gen. nov. & sp. nov., Kuwait.

108 - MOUSTAFA A.F., 1981. A new species of *Sporothrix* from Kuwait. Persoonia 11: 392-394. *Sporothrix ranii* Mustafa, Kuwait.

109 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1989. *Setosporella*, a new genus of hyphomycetes from Egyptian soils. Mycological Research 93: 227-229. *Setosporella mahmoudii* Mustafa & Abdul-Wahid gen. nov. & sp. nov., Egypt.

110 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1990. *Chaetomiopsis*, a new perithecial ascomycete genus from Egyptian soils. Mycologia 82: 129-131. *Chaetomiopsis dinae* Mustafa & Abdel-Wahid gen. nov. & sp. nov., Egypt.

111 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1990. *Scopulariopsis hanii*, a new annellidic hyphomycete from Egyptian soil. Nova Hedwigia 51: 475-482. *Scopulariopsis hanii* Mustafa & Abdel-Wahid, Egypt.

112 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1990. *Mucobasispora,* a new dematiaceous hyphomycete genus from Egyptian soil. Mycological Research 94: 131-135. *Mucobasispora tarikii* Mustafa & Abdel-Wahid gen. nov. & sp. nov., Egypt.

113 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1990. *Thielavia aegyptiaca*, a new thermotolerant ascomycete from Egyptian soils. Persoonia 14: 173-175. *Thielavia aegyptiaca* Mustafa & Abdel-Wahid, Egypt.

114 - MOUSTAFA A.F. & ABDEL-WAHID O.A., 1990. *Veronaea constricta*, a new hyphomycete from Egyptian soils. Mycotaxon 38: 167-171. *Veronaea constricta* Mustafa & Abdel-Wahid, Egypt.

115 - MOUSTAFA A.F. & EZZ EL-DIN E.K., 1989. *Lasiobolidium aegyptiacum*, a new ascomycete from Egyptian soils. Mycological Research 92: 376-378. *Lasiobolidium aegyptiacum* Mustafa & Ezz Eldin, Egypt.

116 - MOUSTAFA A.F. & EZZ EL-DIN E.K., 1989. *Gilmaniella multiporosa*, a new dematiaceous hyphomycete from Egyptian soils. Mycological Research 92: 502-505. *Gilmaniella multiporosa* Mustafa & Ezz Eldin, Egypt.

117 - MOUSTAFA A.F. & EZZ EL-DIN E.K., 1989. *Chaetomium sinaiense* sp. nov., a new soil ascomycete from Egypt. Canadian Journal of Botany 67: 3417-3419. *Chaetomium sinaiense* Mustafa & Ezz Eldin, Egypt.

118 - MOUSTAFA A.F. & EZZ EL-DIN E.K., 1990. *Trichocladium ismailiense*, a new dematiaceous hyphomycete from Egyptian soils. Nova Hedwigia 50: 255-259. *Trichocladium ismailiense* Mustafa & Ezz Eldin, Egypt.

119 - MUHSIN T.M. & AL-HELFI M.A., 1981. Hyphomycetes of Iraq - The Genus *Stachybotrys*. Sydowia 34: 130-134. *Stachybotrys guttulispora* Muhsin & El-Helfi, Iraq.

120 - MULDER J.L., 1989. *Pleospora eucalypti* sp. nov. from Kuwait. Mycological Research 92: 116-118. *Pleospora eucalypti* J.L. Mulder, Kuwait.

121 - NAVROTSKAYA I.L., KONDRATYUK S.Y., WASSER S.P., NEVO E. & ZELENKO S.D., 1996. Lichens and lichenicolous fungi new for Israël and other countries. Israël Journal of Plant Sciences 44: 171-193. *Lichenochora wasserii* S.Y. Kondr., Israël.

122 - NEMLICH H. & AVIZOHAR-HERSHENZON Z., 1976. Pezizales of Israël. IV. Humariaceae (B). Israël Journal of Botany 25: 41-52. *Pulvinula constellatio* (Berk. & Br.) Boud. var. *microspora* Nemlich & Aviz.-Hersh., Israël.

123 - NETZER D. & WEINTAL C., 1987. *Fusarium* wilt of common Heliotrope (*Heliotropium europaeum*). Phytoparasitica 15: 139-140. *Fusarium oxysporum* Schltdl. forma specialis *heliotropii* Netzer & Weintal, Israël.

124 - NICOT J. & MOUCHACCA J., 1972. Une nouvelle espèce du genre *Idriella*. Revue de Mycologie, Paris 36: 185-193. *Idriella desertorum* Mouch., Egypt.

125 - PETRAK F. von, 1941 (1942). Beiträge zur Kenntnis der orientalischen Pilzflora. Annalen des naturhistorischen Museums in Wien 52: 301-396. *Ascochtytella thymii* Petr., Iraq.

126 - PETRAK F. von, 1947. *Neobroomella* n. gen., eine neue Gattung der Sphaeriales. Sydowia, Annales Mycologici, Ser. II, 1: 5-8. *Neobroomella ciliata* Petr. gen. nov., sp. nov. and *Pestalozzia insueta* Petr.; both from present Lebanon.

127 - PETRAK F. von, 1947. *Thryptospora* n. gen., eine neue, sehr isoliert stehende Gattung der Pyrenomyceten. Sydowia, Annales Mycologici, Ser. II, 1: 52-54. *Thryptospora singularis* Petr. gen. nov. & sp. nov., from present Lebanon.

128 - PETRAK F. von , 1947. Zwei neue Pilze aus Syrien. Sydowia, Annales Mycologici, Ser. II, 1: 41-43. *Didymella syriaca* Petr. and *Plenodomus syriacus* Petr.; both from present Lebanon.

129 - PETRAK F. von, 1957 (1958). Beiträge zur Kenntnis der auf *Crucianella* vorkommenden Arten der Gattung *Puccinia*. Sydowia 11: 311-314. *Puccinia crucianellae* Desm. var. *crucianellae-macrostachyae* Petr.: *nom. inval.*, Art. 37.1 ICBN, Israël.

130 - POELT J. & SULZER M., 1974. Die Erdflechte *Buellia* epigea, eine sammelart. Nova Hedwigia 25: 173-191. *Buellia zoharyi* Galun ex Poelt & M. Sulzer, Israël.

131 - RAGHU-KUMAR S., ZAINAL A. & GARETH-JONES E.B., 1988. *Cirrenalia basiminuta*: a new lignicolous marine deuteromycete from the tropics. Mycotaxon 31: 163-170. *Cirrenalia basiminuta* Raghuk. & Zainal, Kuwait.

132 - RAMON E., 1968 (1969). Myxomycetes of Israël. Israël Journal of Botany 17: 207-211. *Physarum rayssiae* Ramon, Israël.

133 - RATTAN S.S. & ABDULLAH S.K., 1976 (1977). Studies on the wood rot fungi of Iraq. Indian Phytopathology 29: 296-302. *Galzinia cystidiata* S.S. Rattan & Abdullah, Iraq.

134 - RATTAN S.S. & AL-DBOON A.-H.A., 1980. Notes on fungi associated with date-palm I. Sydowia 33: 246-264. *Hyphoderma puberum* (Fr.) Wallr. var. *dactyliferum* S.S. Rattan & Al-Dboon [as *pubera* var. *dactylifera*], Iraq.

135 - RAYSS T., 1940. Nouvelle contribution à l'étude de la mycoflore de Palestine (Deuxième partie). Palestine Journal of Botany, Jerusalem Series 1: 313-315. *Oidium matthiolae* Rayss sp. nov. *ad interim.*: *nom. inval.*, Art.34.1b ICBN, Palestine-Israël.

136 - RAYSS T., 1942. On some lower fungi of Palestine. Palestine Journal of Botany, Jerusalem Series 2: 247-249. *Urophlyctis astomae* Rayss and *U. eryngii* Rayss; both from Palestine-Israël.

137 - RAYSS T., 1943. Contribution à l'étude des deutéromycètes de Palestine. Palestine Journal of Botany, Jerusalem Series 3: 22-51. *Cercospora judaica* Rayss: a later synonym of *Phaeoramularia dissiliens* (Duby) Deighton, *Cytosporina crataegi* Allesch. forma *obesispora* Rayss: a later synonym of *C. crataegi* Allesch., *Phyllosticta fusiformis* N. Aggéry & Aggéry forma *microcarpa* Rayss: a later synonym of *P. fusiformis* N. Aggéry & Aggéry, *Septoria koeleriae* Cocc. & Morini var. *macrocarpa* Rayss: a later synonym of *S. koeleriae* Cocc. & Morini and *Septoria urticae-piluliferae* Rayss; all from Palestine-Israël.

138 - RAYSS Y., 1946. Nouvelle contribution à l'étude de la mycoflore de Palestine (Troisième partie). Palestine Journal of Botany, Jerusalem Series 3: 151-166. *Actinomucor corymbosus* (Harz) Naumov forma *palaestina* Rayss: a later synonym of *A. elegans* (Eidam) C.R. Benj. & Hesselt., *Peronospora medicaginis-orbicularis* Rayss, *Peronospora rumicis-rosei* Rayss and *Peronospora veronicae-cymbalariae* Rayss; all from Palestine-Israël.

139 - RAYSS T., 1946. Contribution à la flore mycologique du Proche Orient. Bulletin Trimestriel de la Société Mycologique de France 38: 5-41. *Ascochyta orobi* Sacc. forma *macrocarpa* Rayss: a later synonym *of A. pisi* Lib., *Erysiphe communis* (Wallr.) Link forma *fibigiae* Rayss: a later synonym of *E. crucifearum* Opiz ex Juell, *Guignardia euphorbiae* Rayss, *Stegonsorium centaureae* Rayss [as *Steganosporium*]; all from present Lebanon. *Tilletia sphenopodis* Rayss, from Syria.

140 - RAYSS T., 1947. Nouvelle contribution à l'étude de la mycoflore de Palestine (Quatrième partie). Palestine Journal of Botany, Jerusalem Series 4: 59-76. *Saccobolus kerverni* (P. Crouan) Boud. forma *minor* Rayss: *nom. inval.*, Art. 36.1 ICBN, Paestine-Israël.

141 - RAYSS T., 1950. Nouvelle contribution à l'étude de la mycoflore de Palestine (Cinquième partie). Palestine Journal of Botany, Jerusalem Series 6: 17-27. *Cercospora cephalariae* Rayss, *Rhopalomyces elegans* Corda forma *minor* Rayss: *nom. inval.*, Art. 36.1 ICBN and *Septoria erodii* Rayss; all from Palestine-Israël.

142 - RAYSS T., 1951. Nouvelle contribution à la connaissance des Urédinées de Palestine. In Guyot *Uredineana* 3: 154-221. *Puccinia rimosa* (Link) G. Winter forma *nattrassii* Rayss: *nom. inval.*, Art. 36.1 ICBN and *Uromyces anthyllidis* (Grev.) Schröt. forma *trigonellae* Rayss; both from Palestine-Israël.

143 - RAYSS T., 1952. Etude de quelques Ustilaginées récoltées en Palestine. Palestine Journal of Botany, Jerusalem Series 5: 229-236. *Entyloma ambrosiae-maritimae* Rayss and *Entyloma parietariae* Rayss; both from Palestine-Israël.

144 - RAYSS T., 1953. Nouvelle contribution à l'étude de la mycoflore de Palestine (Sixième partie). Palestine Journal of Botany, Jerusalem Series 6: 37-46. *Sphaerulina serograpta* (Durrieu & Mont.) Sacc. var. *calliprini* Rayss [as *calli-prinos*], Palestine-Israël.

145 - RAYSS T., 1955. Nouvelle contribution à la connaissance des deutéromycètes de Palestine. Bulletin of the Research Council of Israël, Section D, Botany 5: 37-46. *Cercospora rhagadioli* Bubák var. *palaestina* Rayss: a later synonym of *Cercospora rhagadioli* Bubák, *Cercosporina hierosolymitana* Rayss and *Septoria withaniae* Rayss; all from Palestine-Israël.

146 - RAYSS T., 1961. Espèces nouvelles de *Peronospora* parasitant les trèfles. In: Probleme actuale de biologie si stiinte agricole. Lucrare dedicata Acad. Prof. G. Ionescu siseti cu prilejul implinirii a 75 deani. Ed. Academiei republicii populare romine: 195-204. *Peronospora trifolii-cherleri* Rayss: *nom. inval.*, Art. 37.1 ICBN, *P. trifolii-clypeati* Rayss: *nom. inval.*, Art. 37.1 ICBN, *P. trifolii-formosi* Rayss, *P. trifolii-pilularis* Rayss: *nom. inval.*, Art. 37.1 ICBN and *P. trifolii-purpurei* Rayss: *nom. inval.*, Art. 37.1 ICBN; all from Israël.

147 - RAYSS T. & BORUT S., 1958. Contribution to the knowledge of soil-fungi in Israël. Mycopathologia Mycologia Applicata 10: 142-174. *Actinomucor corymbosus* forma *palaestina* Rayss: a later synonym of *A. elegans* (Eidam) C.R. Benj. & Hesselt., *Pericona pycnospora* Fres. forma *israelitica* Rayss & Borut: *nom. inval.*, Art. 37.1 ICBN, *Thielavia terricola* (Gilman & E.V. Abbott) C.W. Emmons forma *minor* Rayss & Borut: a later synonym of *T. terricola* (Gilman & E.V. Abbott) C.W. Emmons; all from Israël.

148 - RAYSS T. & CHABELSKA Ch., 1958. Quelques précisions sur les Urédinées hétéroxènes de Palestine. In Guyot *Uredineana* 5: 5-9. *Uromyces poae* Rabenh. forma specialis *asiatici-hackelii* Rayss & Chabelska, Israël.

149 - REICHERT I. & AVIZOHAR-HERSHENZON Z., 1959. A contribution to the knowledge of higher fungi of Israël. Bulletin Research Council of Israël, Sect. D, Botany 7: 222-247. *Crepidotus variabilis* var. *stercorarius* Reichert & Aviz.-Hersh., *Lepista sordida* var *gracilis* Reichert & Aviz.-Hersh.: *nom. inval.*, Art. 37.1 ICBN and *Tricholoma weizianum* Reichert & Aviz.-Hersh.: *nom. inval.*, Art. 37.1 ICBN; all from Israël.

150 - REICHERT I. & CHORIN M., 1965. A new sooty blotch on *Citrus*. Phytopathologia Mediterranea 4: 12-16. *Caenothyrium citri* Reichert & Chorin, Israël.

151 - REICHERT I. & HELLINGER E., 1947. On the occurrence, morphology and parasitism of *Sclerotium bataticola*. Palestine Journal of Botany, Rehovot Series 6: 107-147. *Sclerotium bataticola* Taubenh. subspecies *intermedia* Reichert & Hellinger, *S. bataticola* Taubenh. subspecies *sesamica* Reichert & Hellinger, *S. bataticola* Taubenh. subspecies *typica* Reichert & Hellinger: all three subspecies are later synonyms of *Rhizoctonia bataticola* (Taubenh.) E.J. Butler *apud* Briton-Jones; all from Palestine-Israël.

152 - RODRIGUEZ de Miranda L., 1979. *Clavispora*, a new yeast genus of the Saccharomycetales. Antonie van Leeuwenhoek 45: 479-485. *Clavispora lusitaniae* Rodr. Mir. gen. nov. *et* sp. nov., Israël.

153 - ROSSI W., 1974. Una nuova specie di *Laboulbenia* (Ascomycetes, Laboulbeniales) parassita di termiti. Doriana 5 (215): 1-5. *Laboulbenia felicis-caprae* W. Rossi: *nom. inval.*, Art. 37.1 ICBN, Lybia.

154 - ROSSI W., 1984 (1986). Una nuova specie di *Stigmatomyces* (Laboulbeniales) rinvenuta su un dittero del Sudan. Bolletino del Museo Civico di Storia naturale di Venezia 35: 163-165. *Stigmatomyces ligabuei* W. Rossi, The Sudan.

155 - ROTEM J., COHEN Y. & WAHL I., 1966. A new Tomato foliage disease in Israël caused by *Stemphylium botryosum*. Canadian Journal of Plant Sciences 46: 265-270. *Stemphylium botryosum* Wallr. forma specialis *lycopersici* Rotem, Cohen & Wahl, Israël.

156 - SAGE L., STEIMAN R., SEIGLE-MURANDI F. & GUIRAUD P., 1995. Description and physiological properties of two new varieties and one new species of *Microascus* from Israël. Mycotaxon 55: 189-201. *Microascus desmosporus* var.

Microascus from Israël. Mycotaxon 55: 189-201. *Microascus desmosporus* var. *macroperithecia* Sage *et al.*: *nom. inval.*, Art. 37.5 ICBN, *M. dimonotus* Sage *et al.*: *nom. inval.*, Art. 37.5 ICBN, *M. trigonosporus* var. *macroperithecia* Sage *et al.*: *nom. inval.*, Art. 37.5 ICBN; all from Israël.

157 - SAMRA A.S., SABET K.A. & HINGORANI M.K., 1963. Late wilt disease of maize caused by *Cephalosporium maydis*. Phytopathology 53: 402-406. *Cephalosporium maydis* Samra, Sabet & Hingorani: now *Harpophora maydis* (Samra *et al.*) W. Gams, Egypt.

158 - SAMSON R.A. & ABDEL-FATTAH H.M., 1978. A new species of *Talaromyces* and a discussion of some recently described taxa. Persoonia 9: 501-504. *Talaromyces assiutensis* Samson & Abdel-Fattah: now *T. trachyspermus* (Shear) Stolk & Samson var. *assiutensis* (Samson & Abdel-Fattah) Yaguchi & Udagawa, Egypt.

159 - SAMSON R.A. & MOUCHACCA J., 1974. Some interesting species of *Emericella* and *Aspergillus* from Egyptian desert soil. Antonie van Leeuwenhoek 40: 121-131. *Emericella desertorum* Samson & Mouch., Egypt.

160 - SAMSON R.A. & MOUCHACCA J., 1975. Additional notes on species of *Aspergillus*, *Eurotium* and *Emericella* from Egyptian desert soil. Antonie van Leeuwenhoek 40: 121-131. *Aspergillus floriformis* Samson & Mouch.: a later synonym of *A. peyronelii* Sappa, *A. pseudodeflectus* Samson & Mouch.: now *A. ustus* (Bain.) Thom & Church var. *pseudodeflectus* (Samson & Mouch.) Kozak., *Eurotium xerophilicum* Samson & Mouch. and *Emericella purpurea* Samson & Mouch.; all from Egypt.

161 - SAMSON R.A. & MOUCHACCA J., 1975. Two new soil-borne cleistothecial Ascomycetes. Canadian Journal of Botany 53: 1634-1639. *Rhexothecium globosum* Samson & Mouch. gen. nov. *et* sp. nov., Egypt.

162 - SAMSON R.A., STOLK A.C. & HADLOK R., 1976. Revision of the subsection *fasciculata* of *Penicillium* and some allied species. Studies in Mycology, Baarn 11: 1-47. *Penicillium italicum* Wehmer var. *avellaneum* Samson & Gutter: a later synonym of *Penicillium italicum* Wehmer, Israël.

163 - SIMMONS E.G., 1989. Perfect States of *Stemphylium*. III. Memoirs of the New York Botanical Garden 49: 305-307. *Pleospora gracilariae* E.G. Simmons & Schatz: anamorph *Stemphylium gracilariae* E.G. Simmons, Israël.

164 - SIMMONS E.G., 1995. *Alternaria* themes and variations (112-144). Mycotaxon 55: 55-163. *Alternaria selinii* E.G. Simmons, Saudi Arabia.

165 - SIMMONS E.G., 1999. *Alternaria* themes and variations (226-235). Classification of *Citrus* pathogens. Mycotaxon 70: 263-323. *Alternaria dumosa* E.G. Simmons and *A.. interrupta* E.G. Simmons; both from Israël.

166 - SIVANESAN A., 1984. New species of *Exserohilum*. Transactions of the British Mycological Society 83: 319-329. *Exserohilum oryzinum* Sivan., Egypt.

167 - SIVANESAN A., ABDULLAH S.K. & ABBAS B.A., 1993. *Exserohilum curvisporum* sp. nov., a new hyphomycete from Iraq. Transactions of the British Mycological Society 97: 1486-1487. *Exserohilum curvisporum* Sivan., Abdullah & Abbas, Iraq.

168 - SOLEL S., MADAR Z., KIMCHI M. & GOLAN Y., 1987. *Diplodia* canker of cypress. Canadian Journal of Phytopathology 9: 115-118. *Diplodia pinea* (Desm.) J. Kickx fil. forma specialis *cupressi* Solel *et al.*, Israël.

169 - SPOONER B.M., 1984. A new species of *Sphacelotheca* (Ustilaginales) on *Suddia sagittifolia* from the Sudan. Kew Bulletin 39: 463-465. *Sphacelotheca sudddiana* Spooner: now *Ustilago suddiana* (Spooner) Vánky, The Sudan.

170 - STEIMAN R., GUIRAUD P., SAGE L. & SEIGLE-MURANDI F., 1994. New strains from Israël in the *Aspergillus niger* group. Systematic and Applied Microbiology 17: 620-624. *Aspergillus homomorphus* Steiman *et al.*: *nom. inval.*, Art. 37.4 ICBN and *A. pseudoheteromorphus* Steiman *et al.*: *nom. inval.*, Art. 37.4 ICBN; both from Israël.

171 - STEIMAN R., GUIRAUD P., SEIGLE-MURANDI F. & SAGE L., 1996. *Bipolaris israelii* sp. nov. from Israël: Description and physiological features. Systematic and Applied Microbiology 19: 182-190. *Bipolaris israelii* Steiman *et al.*, Israël.

172 - STEIMAN R., GUIRAUD P., SEIGLE-MURANDI F. & SAGE L., 2000. *Exserohilum israelii*, a new species isolated from soil from Timna Park (Israël), and its physiological properties. Antonie van Leeuwenhoek 78: 153-161. *Exserohilum israelii* Steiman *et al.*, Israël.

173 - STOLK A.C., 1964. *Aspergillus flaschentraegeri* sp. nov. Transactions of the British Mycological Society 47: 123-126. *Aspergillus flaschentraegeri* Stolk, Egypt.

174 - SUTTON B.C., CAMPBELL C.K. & GOLDSCHMIED-REOUVEN A., 1991. *Pseudomicrodochium fusarioides* sp. nov., isolated from human bronchial fluid. Mycopathologia 114: 159-161. *Pseudomicrodochium fusarioides* B. Sutton & C.K. Campb., Israël.

175 - UDAGAWA S.-I. & UEDA S., 1982. A new *Eupenicillium* species with reticulately ornamented ascospores. Mycotaxon 14: 266-272. *Eupenicillium sinaicum* Udagawa & S. Ueda, Egypt.

176 - UDAGAWA S.-I., HORIE Y. & ABDULLAH S.K., 1985. *Trichurus dendrocephalus* sp. nov. from Iraqi soil. Mycotaxon 23: 253-259. *Trichurus dendrocephalus* Udagawa , Y. Horie & Abdullah, Iraq.

177 - UDAGAWA S.-I., TAKEYOSHI A. & ABDULLAH S.K., 1986. *Thermophymatospora*, a new thermotolerant genus of basidiomycetous hyphomycete. Mycotaxon 27: 99-106. *Thermophymatospora fibuligera* Udagawa, Takeyoshi & Abdullah, gen. nov. *et* sp. nov., Iraq.

178 - UEDA S. & UDAGAWA S.-I., 1983. *Thermoascus aegyptiacus*, a new thermophilic ascomycete. Transactions of the Mycological Society of Japan 24: 135-142. *Thermoascus egyptiacus* S. Ueda & Udagawa: now *Coonemeria aegyptiaca* (S. Ueda & Udagawa) Mouch., Egypt.

179 - URBAN Z., 1966. Uredinales collected in Iraq by Dr. Emil HADAC. In: Guyot *Uredineana* 6: 5-58. *Aecidium tami* Z. Urb., *Puccinia hadacii* Z. Urb., *Uredo fragrantissima* Z. Urb. and *Uromyces acantholimonis* var. *zagrosica* Urban; all from Iraq.

180 - VÁNKY K., 1983. Ten new species of Ustilaginales. Mycotaxon 18: 319-336. *Entyloma taraxaci* Vánky, Israël.

181 - VÁNKY K., 2000. Taxonomical Studies on Ustilaginales. XX. Mycotaxon 74: 161-215. *Sporisorium eriochloae* Vánky, The Sudan.

182 - VINCENT M.A. & PITT J.I., 1989. *Penicillium allii*, a new species from Egyptian garlic. Mycologia 81: 300-303. *Penicillium allii* Vincent & Pitt, Egypt.

183 - WASSER S.P., 1995. New and noteworthy species of the genus *Agaricus* L. : Fr. emended Karsten from Israël. Documents Mycologiques 25 (nos. 98-100): 469-478. *Agaricus bonii* Wasser and *A. nevoi* Wasser; both from Israël.

184 - WASSER, S.P., 1996. New, remarkable and rare higher Basidiomycetes from Israël. Ceska Mycologia (Praha) 48: 237-250. *Agaricus herinkii* Wasser, Israël.

185 - WERNER R.G., 1963. Notes de lichénologie libano-syrienne. VII. Bulletin de la Société Botanique de France 110: 311-318. *Adelococcus lecanorae* Werner, Syria.

186 - ZUNDEL G.L., 1944. Notes on the Ustilaginales of the World. IV. Mycologia 36: 400-412. *Ustilago jehudana* Zundel: now *Bauhinus jehudana* (Zundel emended Denchev) Denchev, Israël.

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BIBLIOGRAPHY

AL-MUSALLAM A., 1987. New and noteworthy fungi from Kuwait. Journal of the University of Kuwait (Science) 14: 337-350.

EL-ABYAD M.S., 1997. Biodiversity of Fungal Biota in Egypt. Up-dated check-list. Publication of National Biodiversity Unit, Egypt, No. 7, 113 pp.

EL-BUNI A.M. & RATTAN S.S., 1981. Check-list of Libyan Fungi. Al Faateh University, Faculty of Science, Department of Botany, Tripoli, Libya, 169 pp.

GREUTER *et al.* (Eds.), 2000. International code of botanical nomenclature. *Regnum Vegetabile* 138: 1-474.

JOHNSTON A. & BOOTH C., (Eds.) 1983. Plant Pathologist's Pocketbook. 2nd Ed. CAB International UK, 439 pp.

KIRK P.M. & ANSELL A.E., 1992. Authors of fungal names. Index of Fungi Supplement. CAB International, Oxon, UK.

MOUBASHER A.H., 1993. Soil fungi of Qatar and other Arab Countries. The Scientific and Applied Research Centre, University of Qatar, 566 pp.

MOUCHACCA J., 1995. Check-list of novel fungi from the Middle East described mainly from soil since 1930. Sydowia 47: 240-257.

MOUCHACCA J., 1999. A list of novel fungi described from the Middle East, mostly from non-soil substrata. Nova Hedwigia 68: 149-174.

MOUCHACCA J., 2001 a. Biodiversité des récentes découvertes fongiques, dans les états arides de l'est méditerranéen. Bocconea 13: 131-143.

MOUCHACCA J., 2001 (2003) b. New fungi described from north east Africa and other Arab countries since 1940. What conclusions could be drawn from this scientific activity ? African Studies Review (Cairo University) 23: 49-84.

MOUCHACCA J., 2004. Novel fungal taxa from the Middle East (1940-2000): Omissions from previous notes. Cryptogamie, Mycologie (in press).

MOUSTAFA A.F., 1986. Additional species as new records for the fungal flora of Kuwait. Journal of the University of Kuwait (Science) 2: 67-88.

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FOLIICOLOUS LICHENS AND THEIR LICHENICOLOUS ASCOMYCETES FROM YUNNAN AND TAIWAN

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Abstract: Foliicolous lichens from Taiwan and foliicolous lichens and their lichenicolous ascomycetes from the Xishuangbanna region in Yunnan are reported, based on recent field work by some of the authors. The vast majority of the species encountered are new records for China and/or Taiwan. *Musaespora coccinea*, so far only known from Papua New Guinea, is reported from two countries on the Northern hemisphere, viz. Brunei and China, and from Queensland in Australia. The accompanying species in the three collecting localities are listed, with all species mentioned from Brunei being new records for that country.

Key words: China, Australia, Brunei, *Musaespora*

Introduction

Taiwan and China are situated at the northern border of extension of the tropical rain forest. This is the natural habitat for species-rich vegetations of foliicolous lichens and their lichenicolous ascomycetes. So far, no lichenicolous fungi on foliicolous lichens and only 20 species of foliicolous lichens have been recorded from China, all from the Xishuangbanna region in Yunnan (Wei & Jiang 1991). Some previous and further records are reported from Fujian, Hainan, Hunan and Yunnan by Santesson 1952 (*Bacidina pallidocarnea, Byssoloma tricholomum, Calopadia puiggarii, C. subcoerulescens, Coenogonium subluteum, Mazosia rotula, Porina epiphylla, P. sphaerocephala, Sporopodium citrinum, Strigula melanobapha, S. smaragdula, S. subtilissima*), Lücking 1997 (*Echinoplaca handelii*), Lücking et al. 2001 (*Echinoplaca* *tetrapla*), From the remainder of China virtually no foliicolous lichens are known, except for some records from Hong Kong (Aptroot & Seaward 1999; Aptroot & Sipman 2001), where the foliicolous flora is poor with less than a dozen species, possibly partly due to the poor state of the forests. Recently, several foliicolous lichens have been reported from Taiwan, mainly pyrenocarpous species (Aptroot 2003), but also other microlichens (Aptroot & Sparrius 2003). Foliicolous lichens were especially reported from conifer needles, e.g. *Fellhanera subternella, F. subtilis* and *Fellhaneropsis kurokawae* (Aptroot & Sparrius 2003) and from bamboo, e.g. *Bacidia apiahica, Porina applanata, P. atrocaerulea, P. chrysophora* and *P. leptosperma* (Aptroot 2003).

Here we report many foliicolous lichens from Taiwan (Table 1) and foliicolous lichens and their lichenicolous ascomycetes from the Xishuangbanna region in Yunnan (Table 2), based on recent field work by some of the authors. The vast majority of the species encountered are new records for China and/or Taiwan. Still, the overall foliicolous lichen flora is not species-rich, no doubt due to the position of the region at the northern extension of the tropics.

During a visit to KUN shortly before the fieldwork in Yunnan, a specimen from Hainan Island was identified as *Musaespora coccinea* Aptroot & Sipman. This species with a conspicuously red thallus is unlikely to be overlooked easily, but had previously been reported from Papua New Guinea only, from where it was originally described more than ten years ago (Aptroot & Sipman 1993). However, here we report its occurrence in two additional countries; one on the Northern Hemisphere (Brunei), and one in Queensland in Australia. The accompanying species in the three collecting localities are listed (Table 3), with all species mentioned from Brunei being new records for that country, while all accompanying species from Australia have already been reported (Lücking et al. 2001), although some (e.g. *Mazosia aptrootii* Sipman) have been reported only once before.

Material and methods

Herbarium vouchers are kept for all records, the vast majority in ABL, with some specimens from Yunnan in B and KUN.

Collecting localities and species lists

Table 1: Foliicolous lichens in Taiwan

new	* in this column means new to Taiwan
A	Nantou County, 45 km WNW of Hualien, Meifeng, broadleaf forest remnant on ridge, alt. 2050 m, leg. A. Aptroot, 10 October 2001, on *Machilus*.
B	Same locality, on *Fatsia.*
C	Same locality, on *Hydrangea*
D	Nantou County, Chitou, alt. 1100 m, leg. M.-J. Lai, 25 May 2001, on *Phoebe formosana*.
E	Same locality, on *Alpinia speciosa.*
F	Same locality, on *Asplenium nidus.*
G	Nantou County, 15 km ENE of Puli, near Wushe, river gorge, 950 m. alt., leg. A. Aptroot, 9 October 2001, on *Polystichum.*
H	Same locality, on *Turpinia.*
I	Same locality, on *Arenga.*
J	Pingtung County, Kenting Forest Recreation Area, forest reserve, alt. 200 m, leg. A. Aptroot, 16 October 2001, on *Diospyros*.

New	Table 1. Species in Taiwan	A	B	C	D	E	F	G	H	I	J
*	Actinoplaca strigulacea Müll. Arg.				x						
*	Asterothyrium microsporum R. Sant.		x	x					x		
*	Aulaxina quadrangula (Stirt.) R. Sant.					x	x				
	Bacidina apiahica (Müll. Arg.) Vezda							x			
*	Bacidina pallidocarnea (Müll. Arg.) Vezda		x				x				
	Byssoloma leucoblepharum (Nyl.) Vain.					x					
	Byssoloma subdiscordans (Nyl.) P. James									x	
*	Calenia depressa Müll. Arg.		x								
*	Calenia monospora Vezda					x					
	Calenia sp.						x				
	Calopadia subcoerulescens (Zahlbr.) Vezda			x		x				x	
	Calopadia sp.		x		x		x				
	Caprettia sp.									x	
	Coenogonium subluteum (Rehm) Kalb & Lücking					x					x
*	Echinoplaca epiphylla Fée						x				
*	Echinoplaca hispida Sipman		x		x						
	Echinoplaca leucotrichoides (Vain.) R. Sant.		x		x	x	x			x	
	Fellhanera bouteillei (Desm.) Vezda		x	x			x	x			
*	Fellhanera semecarpi (Vain.) Vezda				x						
*	Gyalectidium catenulatum (Cavalc. & A.A. Silva) Ferraro, Lücking & Sérus.			x							
*	Gyalectidium caucasicum (Elenk. & Woron.) Vezda		x	x				x	x		
*	Gyalectidium filicinum Müll. Arg.							x	x		
*	Gyalideopsis rubescens Vezda		x			x	x				
*	Lyromma nectandrae Batista & Maia			x							
	Mazosia melanophthalma (Müll. Arg.) R. Sant.						x				x
	Porina chrysophora (Stirt.) R. Sant.										x
*	Porina nitidula Müll. Arg.					x	x		x		
*	Porina pallescens R. Sant.								x		
	Porina perminuta Vain.										x
*	Porina rufula (Krempelh.) Vain.					x	x				
*	Sporopodium flavescens (R.Sant.) Vezda					x	x				
*	Sporopodium leprieurii Mont.					x					
	Sporopodium xantholeucum (Müll. Arg.) Zahlbr.					x	x		x		
	Strigula concreta (Fée) R. Sant.	x									
	Strigula nemathora Mont.								x		
	Strigula smaragdula Fr.	x							x		
	Strigula sp. indet.				x						
*	Tricharia armata Vezda									x	
*	Tricharia carnea (Müll. Arg.) R. Sant.			x							
*	Tricharia kashiwadanii G.Thor, Lücking & Tat. Matsumoto					x	x				
	Tricharia vainioi R. Sant.					x	x				x

Table 2: Foliicolous lichens in Xishuangbanna, Yunnan, China

new	* in this column means new to China (including Hong Kong)
A	Menglun, Tropical Botanical Garden, alt. 550 m, leg. A. Aptroot, 1 November 2002.
B	Green Stone Park, 2 km SE of Menglun, alt. 600 m, leg. A. Aptroot & H.J.M. Sipman, 1 November 2002.
C	Menglun, Tropical Botanical Garden, disturbed primary rainforest remnant, alt. 550 m, leg. A. Aptroot & H.J.M. Sipman, 2 November 2002.
D	8 km E of Jinghong, Xishuangbanna Primeval Forest Park, primary forest remnant in narrow valley, alt. 600 m, leg. A. Aptroot, 3 November 2002.

New	Table 2. Species in Yunnan	A	B	C	D
*	Actinoplaca strigulacea Müll. Arg.	x	x	x	x
*	Asterothyrium microsporum R. Sant.			x	
*	Aulaxina quadrangula (Stirt.) R. Sant.		x		x
	Aulaxina sp.		x		
*	Bacidia olivaceorufa Vain.			x	
*	Bacidina mirabilis (Vezda) Vezda			x	
*	Bacidina scutellifera Vezda			x	
	Bacidina sp.	x			
*	Bullatina aspidota (Vain.) Vezda & Poelt		x		
*	Byssolecania variabilis Vezda, Kalb & Lücking			x	
*	Byssoloma leucoblepharum (Nyl.) Vain.			x	x
	Byssoloma subdiscordans (Nyl.) P. James				x
*	Calenia depressa Müll. Arg.	x			
*	Calenia monospora Vezda	x	x	x	
*	Calenia thelotremella Vain.				x
	Calopadia subcoerulescens (Zahlbr.) Vezda	x		x	
	Caprettia sp.			x	
	Coenogonium subluteum (Rehm) Kalb & Lücking	x	x	x	x
*	Coenogonium zonatum (Müll. Arg.) Lücking & Kalb		x		
	Cryptothecia candida (Krempelh.) R. Sant.		x	x	
	Echinoplaca epiphylla Fée	x	x	x	x
*	Echinoplaca leucotrichoides (Vain.) R. Sant.	x	x		
	Fellhanera bouteillei (Desm.) Vezda			x	
*	Fellhanera fuscatula (Müll. Arg.) Vezda			x	
*	Gyalectidium australe Lücking	x			x
*	Gyalectidium caucasicum (Elenk. & Woron.) Vezda	x	x	x	
	Gyalectidium filicinum Müll. Arg.	x	x		
*	Lyromma nectandrae Batista & Maia	x			
	Mazosia melanophthalma (Müll. Arg.) R. Sant.	x		x	x
	Mazosia phyllosema (Nyl.) Zahlbr.		x	x	x
*	Opegrapha ectolechiacearum Matzer & R. Sant.	x			
	Porina albicera (Krempelh.) van Overeem-de Haas			x	
*	Porina conica R. Sant.		x	x	
*	Porina cupreola (Müll. Arg.) Schilling		x		
	Porina epiphylla (Fée) Fée		x	x	
*	Porina epiphylloides Vezda		x		
*	Porina imitatrix Müll. Arg.			x	
*	Porina karnatakensis Makhija et al.			x	
*	Porina lucida R. Sant.		x	x	

*	Porina mirabilis Lücking & Vezda (c. schizidia)			x	
	Porina nitidula Müll. Arg.	x	x	x	
*	Porina rufula (Krempelh.) Vain.	x	x	x	x
*	Porina trichothelioides R. Sant.	x	x		
*	Porina virescens (Krempelh.) Müll. Arg.		x	x	
	Sporopodium leprieurii Mont.	x	x	x	x
*	Sporopodium phyllocharis (Mont.) Massal.			x	x
*	Sporopodium xantholeucum (Müll. Arg.) Zahlbr.	x		x	
*	Stigmidium calopadiae Matzer			x	
*	Stigmidium epiphyllum Matzer	x			
*	Stigmidium trichotheliorum Matzer		x		
*	Strigula concreta (Fée) R. Sant.			x	
*	Strigula maculata (Cooke & Massee) R. Sant.			x	
	Strigula macrocarpa Vain.		x		
*	Strigula minor (Vezda) Sérus.			x	
*	Strigula nemathora Mont.			x	
*	Strigula nemathora var. hypothelia (Nyl.) R. Sant.			x	
*	Strigula nitidula Mont.		x	x	
*	Strigula phyllogena (Müll. Arg.) R.C. Harris		x	x	
	Strigula smaragdula Fr.		x	x	x
	Strigula subtilissima (Fée) Müll. Arg.			x	
*	Tricharia armata Vezda			x	
	Tricharia vainioi R. Sant.			x	
*	Trichothelium alboatrum Vain.	x			x

Table 3: Foliicolous lichens associated with *Musaespora coccinea*

new	* in this column means new to Brunei
A	Australia, Queensland, Atherton Tablelands, Bellenden Ker National Park, Boulders Area, 6 km W of Babinda, 50 m alt., leg. A. Aptroot, 6 August 1999.
B	Brunei Darussalam, Temburong, Kuala Belalong Field Research Centre, leg. W.H. Ho & Yanna, 19 February 1999, on leaves of small herbs along path through rain forest.
C	China, Hainan Province, Le Dong County, Tian Chi Natural Forest Reserve, leg. Xing Jiang Li, 15 December 1989.

New	Table 3. Species associations with Musaespora coccinea	A	B	C
	Actinoplaca strigulacea Müll. Arg.			x
	Arthonia cyanea Müll. Arg.	x		
*	Arthonia intermedia Matzer		x	
*	Arthonia ramosii (Räs.) R. Sant.		x	
	Arthonia sp.		x	
	Aspidothelium fugiens (Müll. Arg.) R. Sant.	x		
	Aulaxina cf. epiphylla (Zahlbr.) R. Sant.	x		
*	Byssolecania fumosonigricans (Müll. Arg.) R. Sant.		x	
	Calenia bullatinoides Lücking	x		
	Calenia graphidea Vain.	x		
	Calenia phyllogena (Müll. Arg.) R. Sant.	x		
	Calenia thelotremella Vain.	x		
*	Calopadia fusca (Müll. Arg.) Vezda		x	
*	Calopadia phyllogena (Müll. Arg.) Vezda		x	

	Calopadia sp.		x	
*	Chroodiscus mirificus (Krempelh.) R. Sant.		x	
	Chroodiscus cf. mirificus (with large spores)		x	
	Coccocarpia cf. pellita (Ach.) Müll. Arg.	x		
	Coenogonium hypophyllum (Vezda) Kalb & Lücking	x		
*	Coenogonium interpositum Nyl.	x	x	
	Coenogonium subluteum (Rehm) Kalb & Lücking	x		
	Cryptothecia sp.	x		
	Echinoplaca leucotrichoides (Vain.) R. Sant.	x		
	Echinoplaca pellicula (Müll. Arg.) R. Sant.	x		
*	Gyalideopsis cochlearifer Lücking & Sérus.		x	
*	Loflammia epiphylla (Fée) Lücking & Vezda		x	
*	Loflammia gabrielis (Müll. Arg.) Vezda		x	
	Mazosia aptrootii Sipman	x		
*	Mazosia bambusae (Vain.) R. Sant.		x	
*	Mazosia melanophthalma (Müll. Arg.) R. Sant.		x	
*	Mazosia paupercula (Müll. Arg.) R. Sant.		x	
	Mazosia phyllosema (Nyl.) Zahlbr.	x		
*	Musaespora coccinea Aptroot & Sipman	x	x	x
*	Opegrapha cf. lambinonii Sérus.		x	
*	Porina applanata Vain.		x	
	Porina distans Vezda & Vivant	x		
*	Porina epiphylla (Fée) Fée		x	
*	Porina imitatrix Müll. Arg.		x	
*	Porina karnatakensis Makhija et al.		x	
	Porina lucida R. Sant.	x		
*	Porina mirabilis Lücking & Vezda		x	
*	Porina rubentior (Stirt.) Müll. Arg.		x	
*	Porina rufula (Krempelh.) Vain.	x	x	
*	Porina virescens (Krempelh.) Müll. Arg.	x	x	
	Porina sp. nov. (aff. lucida, but spores c. 13-septate, 45-85 µm long)		x	
	Porina sp. indet.	x		
*	Semigyalecta paradoxa Vain.		x	
	Sporopodium phyllocharis (Mont.) Massal.	x		x
*	Strigula subtilissima (Fée) Müll. Arg.	x	x	x
*	Tricharia albostrigosa R. Sant.		x	
*	Tricharia leucothrix Mont.		x	
*	Trichothelium epiphyllum Müll. Arg.		x	

Discussion

Most of the taxa reported above are widespread and common, i.e. usually those first found in non-systematic collections. It is surprising that no undescribed taxa were encountered, except for a *Porina* species in Brunei, which is left undescribed here because the available material is rather scanty. Better material will doubtlessly be found in future if the foliicolous lichen flora in the area will be investigated in more detail. Experience shows that with deeper studies, more rare species will be discovered, i.e. even if the communities in these forests are poor in species, there might be quite a number of yet undiscovered taxa.

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Literature cited

Aptroot, A. (2003). Pyrenocarpous lichens and related non-lichenized ascomycetes from Taiwan. Journal of the Hattori Botanical Laboratory 93: 155-173.

Aptroot, A. & Seaward, M.R.D. (1999). Annotated checklist of Hong Kong lichens. Tropical Bryology 17: 57-101.

Aptroot, A. & Sipman, H.J.M. (1993). *Musaespora,* a genus of pyrenocarpous lichens with campylidia, and other additions to the foliicolous lichen flora of New Guinea. Lichenologist 25: 121-135.

Aptroot, A. & Sipman, H.J.M. (2001). New Hong Kong lichens, ascomycetes and lichenicolous fungi. Journal of the Hattori Botanical Laboratory 91: 317-343.

Aptroot, A. & Sparrius, L.B. (2003). New microlichens from Taiwan. Fungal Diversity 13.

Lücking, R. (1997). Additions and corrections to the knowledge of the foliicolous lichen flora of Costa Rica. The family Gomphillaceae. Bibliotheca Lichenologica 65: 1-109.

Lücking, R. Streimann, H. & Elix, J.A. (2001). Further records of foliicolous lichens and lichenicolous fungi from Australasia, with an updated checklist for continental Australia. Lichenologist 33: 195-210.

Santesson, R. (1952). Foliicolous lichens I. A revision of the obligately foliicolous, lichenized fungi. Symbolae Botanicae Upsalienses 12(1): 1-590.

Wei, J.-C. & Jiang, Y.M. (1991). Some foliicolous lichens in Xishuangbanna, China. Pp. 201-216 in: D. Galloway (ed.), Systematics, Conservation and Ecology of Tropical Lichens, Systematics Association Special Volume no. 42. Clarendon Press, Oxford.

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NOMENCLATURE AND TYPIFICATION OF RAMULARIA GREVILLEANA

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ABSTRACT: The anamorph of *Mycosphaerella fragariae*, *Ramularia grevilleana*, is lectotypified, and the nomenclature of this species is discussed in detail. It is demonstrated that the basionym *Cylindrosporium grevilleanum* has to be attributed to C.A.J.A. Oudemans instead of the brothers Tulasne.

Keywords: *Ramularia grevilleana*, nomenclature, typification

INTRODUCTION

Mycosphaerella fragariae (Tul. & C. Tul.) Johanson ex Oudem., the *Mycosphaerella* leaf spot disease of strawberries and other hosts of the Rosaceae, is a common, economically important, almost circumglobal plant-pathogenic fungus (Braun 1998). The first description of the anamorph of this species dates back to Tulasne & Tulasne (1863: 288-290 and Tab. XXXI, Figs 2-6), who described and depicted conidiophores and conidia under *Stigmatea fragariae* Tul. & C. Tul. The conidial form ("Fungus conidiophorus") was cited as follows: "*Graphium phyllogenum* Mazerio, tum in suis *Pl. Crypt. Galliae*, ed. princ. fasc. XLIII (1851), n. 2139, et ed. alt. fasc. XXXV (1850), n. 1739…". On page 286, Tulasne & Tulasne (1863) circumscribed the genus *Stigmatea* Fr. and cited *Cylindrosporium* Grev. ("*Cylindrosporia* Grevilleo et Ungero") as conidial form ("Fungus conidiophorus"), and in the text at the bottom of page 288, they noted that the conidiophores and conidia of *Stigmatea fragariae* were colorless, and thus belonging to Greville´s (1822) genus *Cylindrosporium* ("Conidia haec simul cum suis sterigmatibus modo alba sunt et *Cylindrosporium* Grevillianum constituunt …"). At that time, various authors placed *Ramularia* species in *Cylindrosporium*, influenced by the circumscription of the latter genus by Unger (1833), who altered the name to *Cylindrospora* and included some *Ramularia* species with catenate, cylindrical conidia. In any case, Tulasne & Tulasne (1863) did not introduce a new species for the anamorph of *Stigmatea fragariae*. In their text, all generic names and epithets are printed in italics, but the name concerned reads "*Cylindrosporium* Grevillianum" (i.e., Greville´s name was used as an author name with Latin adjectival ending), which was translated as "Greville´s *Cylindrosporium*" in the English version of this book (Buller & Shear 1931). Several authors misinterpreted "*Cylindrosporium* Grevillianum" to be the name of a new species introduced by Tulasne & Tulasne (1863), e.g., Oudemans (1873, 1874), Saccardo (1886), Jørstad (1945). The first valid denomination and description of the anamorph of *Mycosphaerella fragariae* was published (in French) by Oudemans (1873: 392). He changed the spelling "Grevillianum" to "*grevilleanum*" and provided a full description under "*Cylindrosporium grevilleanum* Tul. (Sel. Carp. Fung. II, p. 288)". However, as discussed above, this name must be attributed to Oudemans. A second description was published (in Latin) by Oudemans (1874: 315, as "*grevillianum*"). Saccardo (1879) introduced the name *Ramularia tulasnei* Sacc. for the *Mycosphaerella fragariae* anamorph, but did not cite *Cylindrosporium grevilleanum*, although a direct reference to Tulasne & Tulasne (1863) was given: "Cfr. Tul. Select. F. Carp. II. 286 (ut stat. conid. *Stigmateae fragariae*)". Saccardo (1886) reduced "*C. grevilleanum* Tul." to synonymy with *R. tulasnei*, and most subsequent authors followed, e.g., Lindau (1907), Ferraris (1913) and Vassiljevsky & Karakulin (1937). Oudemans (1921) cited "*Cylindrosporium grevilleanum* Oud.", suggesting that he had realized that this name ought to be attributed to himself, but he followed Saccardo (1886) in reducing this older name to synonymy with *R. tulasnei*. Jørstad (1945) realized the priority of *Cylindrosporium grevilleanum*, and proposed the new combination *Ramularia grevilleana* (Tul. & C. Tul.) Jørst. The quotation of the brothers Tulasne as authors of the basionym has to be considered a bibliographic error, which can be corrected to *Ramularia grevilleana* (Oudem.) Jørst., since Tulasne & Tulasne (1863: 288) was a part of the protologue of *Cylindrosporium grevilleanum* Oudem.

TYPIFICATION OF *CYLINDROSPORIUM GREVILLEANUM*

Braun (1998) selected the original drawing of the anamorph of *Mycosphaerella fragariae* in Tulasne & Tulasne (1863) as lectotype. This typification is, however, inappropriate, since it was based on "*C. grevilleanum* Tul. & C. Tul." There are potentially two ways to lectotypify *C. grevilleanum* Oudem., viz., to use the collection from the Netherlands (on *Fragaria vesca*, Heemstede, Jul. 1872, Oudemans, L 371868) cited by Oudemans (1873), or to select one of the collections (Desm., Pl. Crypt. France, ed. 1, no. 2139; and ed. 2, no. 1739) cited as "Fungus conidiophorus" of *Stigmatea fragariae* by Tulasne & Tulasne (1863: 288, under *Graphium phyllogenum*), which is part of the protologue. Duplicates of the latter two collections from PC have been re-examined and proved to be *Ramularia grevilleana*. However, the situation is confused by the original identification of these collections as *Graphium phyllogenum* Desm. (≡ *Graphiothecium phyllogenum* (Desm.) Sacc.), which is an unrelated synnematous hyphomycete (see Braun 1993). The Netherlands collection described by Oudemans (1873), which has also been examined, is therefore proposed to serve as lectotype.

CONCLUSION

As pointed out and discussed in this paper, the name *Cylindrosporium grevilleanum* must be attributed to Oudemans (1873), not to the brothers Tulasne (1863). The collection on *Fragaria vesca*, the Netherlands, Heemstede, Jul. 1872, Oudemans (L 371868), is designated as the lectotype of this species.

Ramularia grevilleana (Oudem.) Jørst., Meld. Stat. Plantepatol. Inst. 1: 17. 1945.
≡ *Cylindrosporium grevilleanum* Oudem., Arch. Néerl. Sci. Exact. Nat. 8: 392. 1873.
[= *Cylindrosporium* sp., in Tulasne & Tulasne (1863: 288)].
Lectotype: on *Fragaria vesca*, the Netherlands, Heemstede, Jul. 1872, Oudemans (L 371868), designated here.
[For the complete synonymy, see Braun (1998)].

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We are much obliged to B. Buyck, curator of the mycological herbarium at PC (National Museum of Natural History, Paris, France) for loaning duplicates of Desmazières, Pl. Crypt. France 1739 and 2139; and we are grateful to G. Thijsse (Chief collection manager, Nationaal Herbarium Nederland, Universiteit Leiden branch, Leiden, the Netherlands) for giving us the opportunity to examine the type material of *Cylindrosporium grevilleanum*.

REFERENCES

Braun, U. (1993). Revisiones generum obscurorum hyphomycetum: a revision of *Graphiothecium* Fuckel and *Stromatostysanus* von Höhnel. Sydowia 45: 81-91.

Braun, U. (1998). A monograph of *Cercosporella, Ramularia* and allied genera (phytopathogenic hyphomycetes). Vol. 2. Eching.

Buller, A.H.R. and Shear, C.L. (1931). Selecta fungorum carpologia of the brothers L. R. and C. Tulasne translated into English by W.B. Grove. Volume II. Oxford.

Ferraris, T. (1913). Hyphales, Mucedinaceae. Fl. Ital. Cryptog. Pars I: Fungi, Fasc. 10: 539-846. Rocca S. Casciano.

Greville, R.K. (1822). Scottish cryptogamic flora, Vol. I, Fasc. 6. Edinburgh.

Jørstad, I. (1945). Parasittsoppene på kultur- og nyttevekster i Norge I. Sekksporesopper (Ascomycetes) og konidiesopper (Fungi imperfecti). Meld. Stat. Plantepatol. Inst. 1: 1-142.

Lindau, G. (1907). Dr. L. Rabenhorst´s Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Zweite Auflage. Erster Band: Pilze. Die Pilze Deutschlands, Oesterreichs und der Schweiz. VIII. Abteilung: Fungi imperfecti: Hyphomycetes (erste Hälfte). Mucedinaceae, Dematiaceae (Phaeosporae und Phaeodidymae). Leipzig.

Oudemans, C.A.J.A. (1873). Matériaux pour la flore mycologique de la Néerlande. Arch. Néerl. Sci. Exact. Nat. 8: 343-416.

Oudemans, C.A.J.A. (1874). Aanwinsten voor de flora mycologica van Nederland. Nederl. Kruidk. Arch., 2 Ser., 1(4): 312-318.

Oudemans, C.A.J.A. (1921). Enumeratio systematica fungorum. Vol. III. Den Haag.

Saccardo, P.A. (1879). Fungi gallici lecti a cl. viris P. Brunaud, C.C. Gillet et Abb. Letendre. Michelia 1(5): 500-538.

Saccardo, P.A. (1886). Sylloge fungorum, Vol. IV. Padova.

Tulasne, L.-R. and Tulasne, C. (1863). Selecta fungorum carpologia. Tomus secundus. Xylariei – Valsei – Sphaeriei. Paris.

Unger, F. (1833). Die Exantheme der Pflanzen und einige mit diesen verwandte Krankheiten der Gewächse. Wien.

Vassiljevsky, N.I. and Karakulin, B.P. (1937). Parazitnye nesovershennye griby. I. Gifomitsety. Moskva.

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NEW SPECIES OF MARASMIOID GENERA (BASIDIOMYCETES, TRICHOLOMATACEAE) FROM TROPICAL AFRICA - II. GLOIOCEPHALA, MARASMIUS, SETULIPES AND TWO NEW COMBINATIONS

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Abstract

14 new taxa (13 species and 1 variety) of the genera *Marasmius*, *Gloiocephala* and *Setulipes* (Basidiomycetes, Tricholomataceae) from tropical Africa are published. Two described species belong to the genus *Gloiocephala* (*G. mucrocystidiata, G. tezae*), two to *Marasmius* sect. *Chordales* (*M. mvumae, M. schreursii*), one species and one variety to sect. *Globulares* (*M. latepileatus, M. staudtii* var. *magnisporus*), one to sect. *Hygrometrici* (*M. mulanjensis*), three to sect. *Marasmius* (*M. colorimarginatus, M. lovedalensis, M. somalomoensis*) and four to the genus *Setulipes* (*S. afibulatus, S. brevistipitatus, S. curvistipitatus, S. rhizomorphicola*). Two new combinations are proposed: *Setulipes kisangensis* and *S. hakgalensis*. A new name, *M. davidii*, is proposed for *M. brunneolus* (Berk. & Broome) Pegler [non *M. brunneolus* (Beeli) Singer]. Detailed macroscopic and microscopic descriptions, drawings and a short discussion are given for each species. These studies represent a part of larger taxonomic project dealing with African *Marasmii.*

Key words: Agaricales, new taxa, taxonomy

This paper represents the second part of descriptions of new taxa with short discussions as a result of monographic studies of tropical African marasmioid species. The complete comments, as well as colour photographs, will be published in a monograph, which is currently being prepared.

Microscopic features are described from examined material mounted in Melzer's reagent, Congo Red, and KOH. For basidiospores the following factors are used: E (quotient of length and width in any one spore); Q (mean of E-values).

In the drawings, following abbreviations are used: BS for basidiospores, CH for cheilocystidia, PL for pleurocystidia, PP for pileipellis, PC for pileocystidia and SP for stipitipellis, CA for caulocystidia. Scale bar represents 20 μm.

Gloiocephala mucrocystidiata **Antonín sp. nov.** (Fig. 1)

Pileo 0,7-2 mm lato, campanulato vel convexo, membranaceo, striato, margine subtiliter crenulato, sub lente subtiliter farinoso, albo, centro subtiliter griseolo. Lamellis distantibus, L = 5-7, adnatis, tenuibus, albidis. Stipite ± 15 × 1 mm, cylindraceo, filiforme, insititio, glabro, subtiliter pruinoso, apicem albido, ad basim brunneo-nigro. Basidiosporis (7,0-)8,0-10,0 x 3,5-4,5 µm, subfusiformibus, sublacrymoideis, ellipsoideo-fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 30-58 x (3,0-)7,0-10,5 µm, lageniformibus, fusiformibus vel subcylindraceis, cum apice mucronato. Pleurocystidiis infrequentibus, cheilocystidiis similibus. Pileipellis hymeniformis, 1) e cellulis clavatis, fusiformibus vel subutriformibus, 13-38 × 6,0-13 µm; 2) e cellulis clavatis vel subfusiformibus, irregularibus vel subcoralloideis, refractis. Pileocystidiis infrequentibus vel numerosis, 22-37 × 5,0-10,0 µm, lageniformibus vel fusiformibus, rostratis, cum apice mucronato. Caulocystidiis infrequentibus, 25-195 × (2,5-)5,0-7,0 µm, cylindraceis, sublageniformibus, subfusiformibus, crassitunicatis. Hyphis dextrinoideis, fibulatis. Ad folia putrida.
HOLOTYPUS: Malawi, Lichenya plateau, Boma-path, 19. XI. 1981 leg. J. Rammeloo 7442 (holotypus in herbario BR 011981-50 asservatur).

Carpophores marasmioid. Pileus 0.7-2 mm broad, campanulate or convex, margin slightly crenulate, very thin, rather distinctly striate almost up to centre, apparently smooth, mealy under lens, white, sometimes slightly greyish at centre. Lamellae distant, L = 5-7, adnate, narrow, thin, white. Stipe ± 15 x 1 mm, cylindrical, filiform, smooth, lustrous, entirely finely pruinose, insititious, white to whitish at apex, brown to red-brown towards base, almost black at base when old.
Basidiospores (7.0-)8.0-10.0 x 3.5-4.5 µm, E = 1.9-2.6, Q = 2.2-2.3, subfusoid, ellipsoid-fusoid, sublacrymoid, thin-walled, smooth, hyaline. Basidia 19-24.5 x (5.5-)6.2-8.0 µm, 4-spored, clavate. Basidioles 12-27 x 3.0-9.0 µm, cylindrical, clavate, fusoid. Cheilocystidia 30-58 x (3.0-)7.0-10.5 µm, lageniform, subcylindrical or fusoid, often (sub)capitate, thin- to slightly thick-walled, sometimes with a mucronate cap at apex, hyaline, mucronate cap brownish or yellow-brown in KOH. Pleurocystidia scattered, similar to pleurocystidia. Hyphae of cylindrical to ellipsoid cells, ± thin-walled, smooth, hyaline, sometimes seemingly slightly gelatinised, up to 20 µm wide. Pileipellis a hymeniderm, made up of two types of cells: 1) 13-38 x 6.0-13 µm, clavate, fusoid, subutriform, thin- to slightly thick-walled, hyaline cells; 2) 16-32(-50) x 6.0-14 µm, clavate, subfusoid, irregular to subcoralloid, thick-walled cells, with slightly refractive contents, yellow-brown in KOH. Pileocystidia scattered to numerous, 22-37 x 5.0-10.0 µm, fusoid, lageniform, often rostrate, obtuse to capitate, thin- to slightly thick-walled, hyaline, often with a mucronate cap which is yellow-brown in KOH. Stipitipellis a cutis of cylindrical, parallel, thick-walled (up to 1.5 µm), yellow-brown in KOH, up to 8 µm wide. Stipe medulla hyphae thin-walled, hyaline. Caulocystidia scattered, 25-195 x (2.5-)5.0-7.0 µm, suberect to erect, ± cylindrical, sublageniform, subfusoid to awl-form, thick-walled (up to 1.5 µm), yellow-brown in KOH. Clamp-connections present. Chemical reactions: Basidiospores non-dextrinoid and inamyloid; trama hyphae and pileipellis cells non-dextrinoid, stipe medulla hyphae dextrinoid.
Ecology: Growing on fallen dead leaves in a montane rainforest (alt. c. 2000 m) with dominating *Widdringtonia* and *Podocarpus*.
Distribution: Known only from Malawi at several localities.
Revised specimens: Malawi: Lichenya plateau, Boma-path, 19 Nov. 1981 leg. J. Rammeloo 7442 (BR 011981-50, holotype). – Mount Mulanje, 15 Nov. 1981 leg. J. Rammeloo 7371a (BR 011959-28). – ditto, 18 Nov. 1981 leg. J. Rammeloo 7425 (BR 011974-43).

Gloiocephala mucrocystidiata is characterised in having well-developed lamellae, a well-developed filiform stipe, rather small basidiospores, a pileipellis made up of more types of cells, very long caulocystidia, and dextrinoid stipe medulla hyphae.

Gloiocephala confusa Singer, also with well-developed lamellae, differs by having longer and narrower basidiospores (9.7-12 x 2.7-3.3 µm) and differently shaped cystidia (Singer 1960).

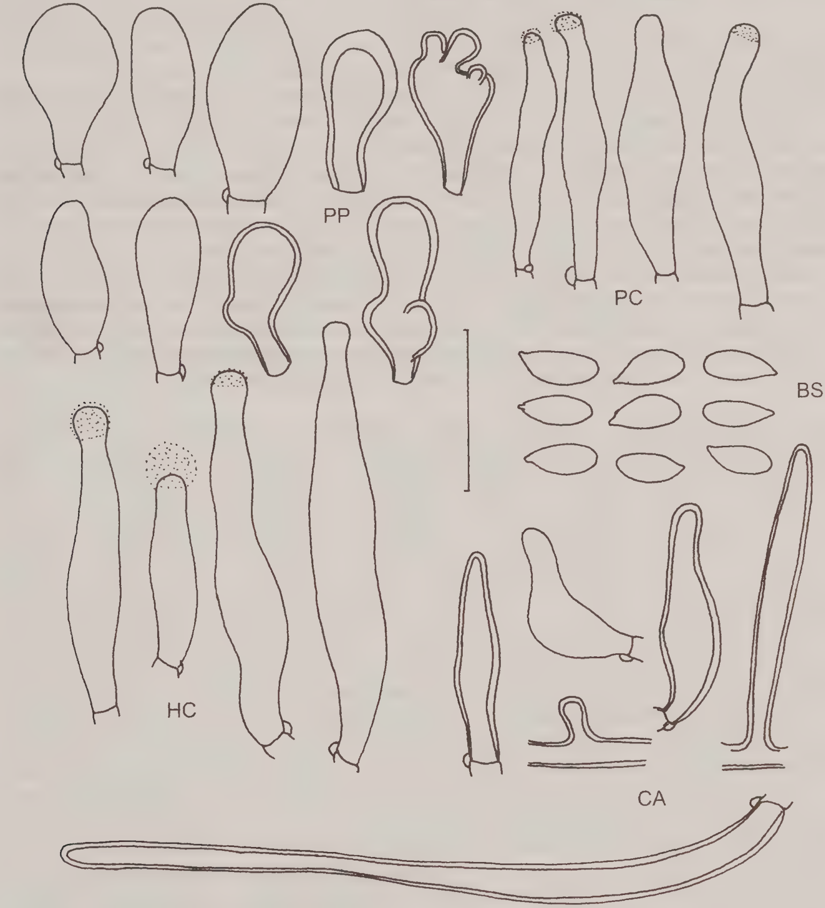

Fig. 1. *Gloiocephala mucrocystidiata* (holotype).

Gloiocephala tezae Antonín sp. nov. (Fig. 2)

Pileo usque 2 mm lato, albo. Lamellis juventute absentis, maturitate pliciformibus, albidis. Stipite obscure brunneo. Basidiosporis (9,6-)10,0-11,5 x 4,4-5,0 µm, lacrymoideis, fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cystidiis hymenialibus 28-37 x 9,2-

11 µm, sublageniformibus, fusiformibus, tenuitunicatis. Pileipellis hymeniformis, e cellulis clavatis, vel fusiformibus, 16-32 × 6,6-15,5 µm, laevibus, tenuitunicatis et e gloeocystidiis clavatis, 24-34 x 14-18 µm. Pileocystidiis 29-36,5 x 10-11 µm, cystidiis hymenialibus similibus. Caulocystidiis 32-38 x 7,5-10 µm, cystidiis hymenialibus similibus. Hyphis dextrinoideis, fibulatis. Ad folia putrida.

HOLOTYPUS: Burundi, T. Muramvya Province, Teza, 21. XII. 1978 leg. J. Rammeloo 6212 (holotypus in herbario BR 011912-78 asservatur).

Carpophores marasmioid. Pileus up to 2 mm, white. Lamellae absent when young, strongly reduced in mature carpophore. Stipe about 4-6 mm long, filiform, dark brown.

Basidiospores (9.6-)10.0-11.5 x 4.4-5.0 µm, E = 2.0-2.4, Q = 2.2, fusoid, lacrymoid, thin-walled, hyaline. Basidia 19-27 x 8.1-9.6 µm, 4-spored, clavate. Basidioles 14-24.5 x 2.5-7.5 µm, cylindrical to clavate. Hymenial cystidia 28-37 x 9.2-11 µm, fusoid, sublageniform, sometimes rostrate, obtuse to subcapitate, thin-walled. Hyphae cylindrical, thin-walled, hyaline, slightly gelatinised, up to 7 µm wide. Pileipellis a hymeniderm, made up of clavate to fusoid, hyaline, 16-32 x 6.6-15.5 µm, ± thin-walled, smooth cells and of scattered, clavate to broadly clavate, 24-34 x 14-18 µm, slightly thick-walled gloeocystidia. Pileocystidia 29-36.5 x 10-11 µm, similar to hymenial cystidia. Stipitipellis a cutis of cylindrical, parallel, thick-walled, up to 5 µm wide hyphae, at apex ± hyaline, brownish yellow towards base. Caulocystidia scattered, 32-38 x 7.5-10 µm, similar to hymenial cystidia, mixed with lateral projections of surface hyphae. Clamp-connections present. Chemical reactions: Basidiospores non-dextrinoid and inamyloid; hyphae, especially of stipe medulla, dextrinoid.

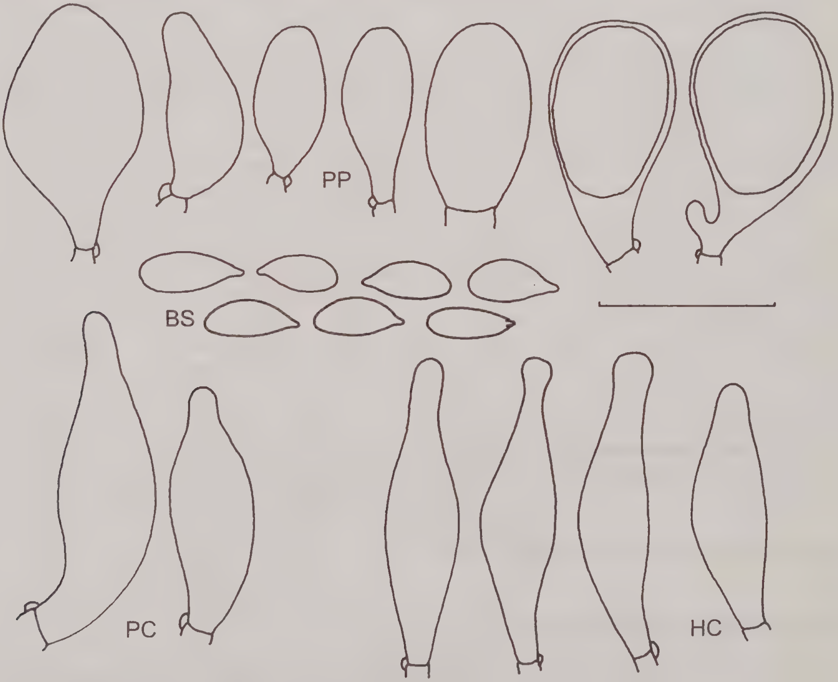

Fig. 2. *Gloiocephala tezae* (holotype).

Ecology: Growing on leaves in a montane rainforest.
Distribution: It has so far been collected only in Burundi at the type locality.
Revised specimens: Burundi: T. Muramvya Province, Teza, 21 Dec. 1978 leg. J. Rammeloo 6212 (BR 011912-78, holotype).

Gloiocephala tezae is characterised in having reduced lamellae, a pileipellis made up of clavate to fusoid cells and gloeocystidia, and by the presence of pileo-, caulo- and hymenial cystidia of similar shape and size, and dextrinoid stipe medulla hyphae.

Marasmius colorimarginatus **Antonín sp. nov.** (Fig. 3)

Pileo 8-10 mm lato, convexo, cum centro depresso, non-papillato, margine crenulato, sulcato, subtiliter tomentoso, brunneo. Lamellis collariatis, L = 13-14, late adnatis, intervenosis, cremeis, acie griseo-brunneis. Stipite 18-22 x 0,1-0,2 mm, filiforme, insititio, glabro, nigro-brunneo. Basidiosporis 8.0-10.0 x 3,5-5,5 µm, ellipsoideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cellulis typi Marasmii rotalis, 16-31 x 9,0-15 µm, late clavatis, hyalinis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii rotalis, 16-32 x 11-20 µm, (late) clavatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite dextrinoideis. Ad folia putrida.
HOLOTYPUS: Cameroon, Sud Province, Somalomo, Dja Biosphere Reserve, 9. IV. 2001 leg. V. Antonín Cm 01.61 (holotypus in herbario BRNM 666128 asservatur).

Pileus 8-10 mm broad, convex, with slightly inflexed crenulate margin, depressed at centre, without central papilla, plicate-striate, slightly tomentose, uniformly coloured, brown (7E5), very slightly darker at centre. Lamellae moderately distant, L = 13-14, l = 0(-1), collariate, broad, intervenose, cream (4A2), with pale grey-brown edge. Stipe 18-22 x 0.1-0.2 mm, filiform, insititious, smooth, glabrous, entirely black-brown. Rhizomorphs present.
Basidiospores 8.0-10.0 x 3.5-5.5 µm, E = 1.7-2.3, Q = 2.0, ellipsoid to pip-shaped, thin-walled, hyaline, smooth. Basidia not found. Basidioles 15-28 x 4.0-8.5 µm, clavate, cylindrical, subfusoid. Cheilocystidia 16-31 x 9.0-15 µm, shaped as broom-cells of the Rotalis-type, (broadly) clavate, hyaline, thin-walled, with thin- to slightly thick-walled projections. Pleurocystidia absent. Trama hyphae cylindrical to subinflated, thin- to slightly thick-walled, branched, up to 15 µm wide, with hyaline to pale brownish walls (especially in subpileipellis) in KOH. Pileipellis a hymeniderm of broom-cells of the Rotalis-type, 16-32 x 11-20 µm, (broadly) clavate, thin- to slightly thick-walled, with thick-walled projections, with hyaline (thin) or brown (thick) walls in KOH. Stipitipellis a cutis, of cylindrical, parallel, slightly thick-walled, up to 5.0 µm wide hyphae with distinctly olivaceous green walls in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reactions: basidiospores, pileus and lamellar trama hyphae non-dextrinoid and inamyloid, stipe medulla and cortex hyphae slightly to distinctly dextrinoid.
Ecology: Saprophytic, growing on dead leaves in a tropical forest.
Distribution: Known only from Cameroon.
Revised specimens: Cameroon: Sud Province, Somalomo, Dja Biosphere Reserve, 9 Apr. 2001 leg. V. Antonín Cm 01.61 (BRNM 666128, holotype).

Marasmius colorimarginatus is characterised by a uniformly brown coloured pileus without central papilla, intervenose lamellae with pale grey-brown edge, a stipe growing up directly from the substrate, rather broad basidiospores (8.0-10.0 x 3.5-5.5 µm) and stipitipellis hyphae with olivaceous green walls in KOH. It belongs to sect. *Marasmius*.

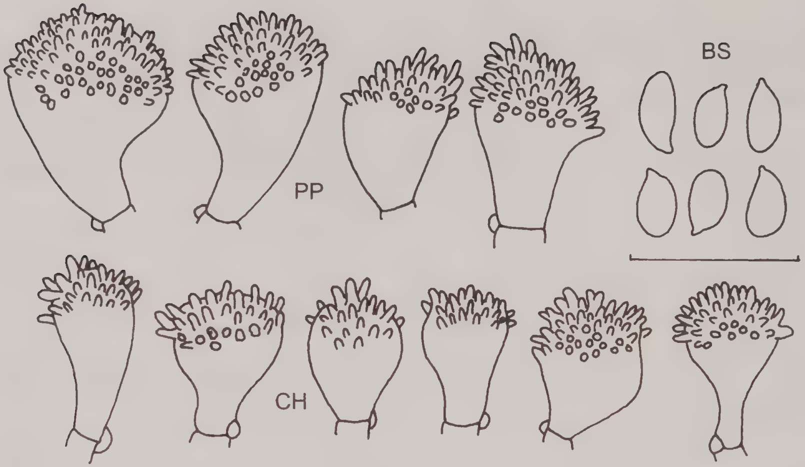

Fig. 3. *Marasmius colorimarginatus* (holotype).

Among species with coloured lamella edge, *Marasmius ubiquipallens* Desjardin & E. Horak has a pale tan and reddish orange tinged pileus and smaller basidiospores (7-9 x 4-4.5 µm, Desjardin & Horak 1997); *M. tubulatus* Petch has a pallid, then greyish brown pileus with a white margin and well-developed black papilla and smaller cheilocystidia (12-16 x 8-11 µm); *M. buzae* Dennis has an orange-ferrugineous or orange-ochraceous pileus, more distant lamellae (L = 7-11) and broader basidiospores, 8.5-13 x (5-)5.7-9(-10.3) µm (Dennis 1970, Singer 1976); *M. arimanus* Dennis has a sepia or mummy brown pileus, less numerous lamellae (L = 7) and broader basidiospores, 11-14 x 3.5-4 µm; *M. violeorotalis* Singer has a violet-lilac pileus and narrower basidiospores (6.2-9.5 x 2.5-3 µm); *M. vigintifolius* Singer has an ochraceous tan, brown or fuscous pileus, more numerous lamellae (L = 17-22) and a long stipe (14-56 mm); *M. idroboi* Singer has a brown, paler radially striped pileus with a distinct central papilla, more numerous lamellae (L = 20-23) and smaller basidiospores (6.5-8 x 2.8-3.8 µm); *M. baeocephalus* Singer has a brown pileus with a white zone in the umbilicus and a well-developed dark papilla, less numerous lamellae (L = 9-11) and smaller basidiospores (6-8 x 3.5-4 µm); *M. variabiliceps* Singer, which has several forms, differs in having a differently coloured pileus and/or different size of basidiospores (cf. Singer 1976).

***Marasmius latepileatus* Antonín & C. Sharp sp. nov.** (Fig. 4)

Pileo usque 100 mm lato, campanulato, dein convexo vel applanato, glabro, sulcato, cremeo-luteolo-griseolo. Lamellis distantibus, L = 20, l = 2, adnatis vel liberis, latis, ventricosis, cremeis. Stipite usque 140 × 8 mm, cylindraceo, non-insititio, glabro, apicem albido-luteolo-griseolo, ad basim aureo-brunneo. Basidiosporis 23-30 x 5,0-7,5 µm, anguste clavatis, lacrymoideis, nonnumquam leviter curvatis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 12-25 x 7,0-11 µm, late clavatis vel subfusiformibus, tenuitunicatis. Pleurocystidiis 37-60 x 9,0-15 µm, clavatis, fusiformibus, tenuitunicatis, refractis. Pileipellis hymeniformis, e cellulis late clavatis vel pyriformibus, 18-30 x 9,0-16 µm, laevibus. Hyphis dextrinoideis, fibulatis.

HOLOTYPUS: Zimbabwe, Midlands Province, Kwekwe, Sable Park, 1829D4, 27. II. 1981 leg. J.M. Stephens (Sharp 817/97, holotypus in herbario BR asservatur).

Pileus up to 100 mm broad, campanulate, then convex to applanate, glabrous, with greasy appearance, except for smooth centre deeply sulcate, beige cream with darker centre. Lamellae distant, L = 20, l = 2, sinuate, adnate or free, ventricose, up to 12 mm broad, cream coloured. Stipe up to 140 x 8 mm, cylindrical, slightly laterally compressed, fistulose, thin-coriaceous, smooth, glabrous, beige cream at apex, up to tan or golden brown towards base, with white basal mycelium. Smell unpleasant, of bad potatoes.

Basidiospores 23-30 x 5.0-7.5 µm, E = 3.7-5.0, Q = 4.3, narrowly clavate, lacrymoid, sometimes curved, thin-walled, hyaline. Basidia 34-38 x 8.0-11 µm, 4-spored, clavate. Basidioles 25-40 x 5.0-10.0 µm, clavate, cylindrical, (sub)fusoid. Cheilocystidia 12-25 x 7.0-11 µm, (broadly) clavate to subfusoid, thin-walled. Pleurocystidia numerous, 37-60 x 9.0-15 µm, fusoid, clavate, thin-walled, with refractive contents. Trama hyphae cylindrical to (sub)inflated, thin-walled, (sub)hyaline in KOH, up to 12 µm wide. Pileipellis a hymeniderm, of 18-30 x 9.0-16 µm, (broadly) clavate, pyriform, smooth, ± thin-walled cells, with subhyaline to pale yellowish walls in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 5.0 µm wide hyphae with pale ochraceous walls in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reaction: basidiospores, hymenium and pileipellis cells non-dextrinoid; hyphae dextrinoid.

Ecology: Saprophytic, in dense clusters or in large groups in a mixed miombo woodland.

Distribution: Known only from the type locality in Zimbabwe.

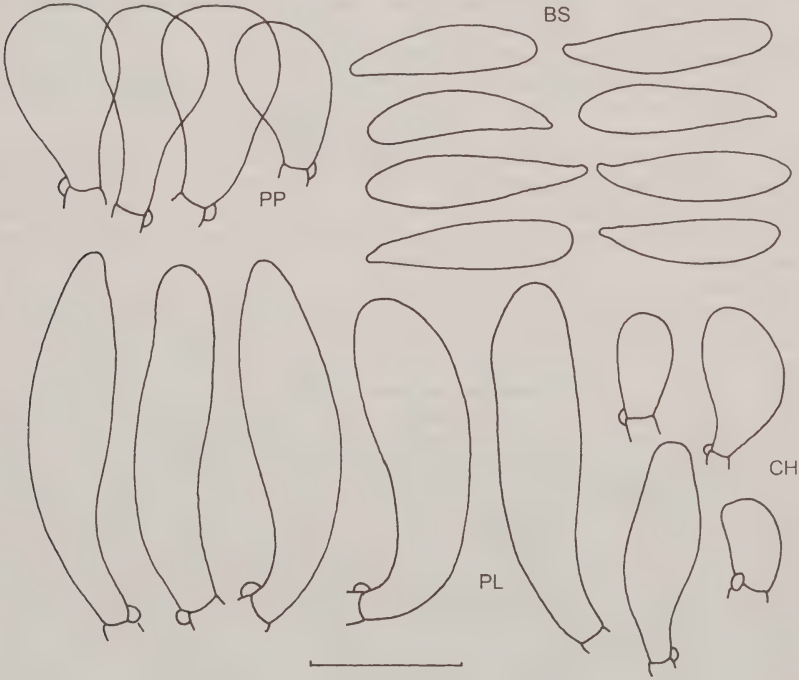

Fig. 4. *Marasmius latepileatus* (holotype).

Revised specimens: Zimbabwe: Midlands Province, Kwekwe, Sable Park, 1829D4, 27 Febr. 1981 leg. J.M. Stephens (Sharp 817/97, BR, holotype).

Marasmius latepileatus is characterised in having very large carpophores, a beige cream pileus with darker centre, very broad lamellae, large basidiospores, small clavate cheilocystidia, well-developed pleurocystidia and by the absence of caulocystidia. It belongs to sect. *Globulares*.

Similar in size of basidiospores and colour of carpophores is *M. flavidulus* Henn., however, it has distinctly smaller carpophores and developed caulocystidia. Other species with very large carpophores are *M. bekolacongoli* Beeli and *M. brunneolus* (Beeli) Singer. Both have differently coloured pilei and pleurocystidia are absent. A species with a similar combination of macroscopic and microscopic features has not been found growing outside of tropical Africa.

Marasmius lovedalensis Antonín & Verbeken sp. nov. (Fig. 5)

Pileo 2-5 mm lato, convexo, cum centro umbilicato et papillato vel non-papillato, margine crenulato, sulcato, aurantiaco, cum centro nigro. Lamellis, L = 8-12, collariatis, late adnatis, obscure cremeis. Stipite 12-15 longo, filiforme, insititio, glabro, nigro. Basidiosporis 11-13(-14,5) x 4,5-6,0 µm, fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 15-20 x 7,0-11 µm, clavatis, subcylindraceis, hyalinis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii sicci, 10-20 x 7,0-12 µm, (late) clavatis, subcylindraceis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite dextrinoideis. Ad ramos putridos.
HOLOTYPUS: Zimbabwe, Mvuma, Lovedale Ranch, 6. II. 1999 leg. A. Verbeken (holotypus in herbario GENT asservatur; isotypus in herbario BRNM 677246 asservatur).

Pileus 2-5 mm broad, convex, with crenulate margin, umbilicate at centre, with small central black dot, without a distinct papilla, plicate-striate, orange (similar to *M. curreyi*). Lamellae moderately distant or distant, L = 8-12, l = 0, collariate, broad, dark cream, with concolorous edge. Stipe 12-15 mm long, filiform, insititious, smooth, glabrous, entirely black. Sterile stipes present.
Basidiospores 11-13(-14.5) x 4.5-6.0 µm, E = 2.1-2.9, Q = 2.5, fusoid, thin-walled, hyaline, smooth. Basidia 25-32 x 8.0-9.0 µm, 4-spored, clavate. Basidioles 16-32 x 5.0-10 µm, clavate, cylindrical, subfusoid. Cheilocystidia 15-20 x 7.0-11 µm, shaped as broom-cells of the Siccus-type, clavate, subcylindrical, thin-walled, upper part slightly thick-walled, with slightly thick-walled, rarely thin-walled, nodulose, subacute to obtuse, up to 5.0(-6.0) x 1.0 µm large projections; thick-walled parts subhyaline to pale yellow-ochraceous. Pleurocystidia absent. Trama hyphae cylindrical to subinflated, ± thin-walled, branched, hyaline, up to 12 µm wide. Pileipellis a hymeniderm of broom-cells of the Siccus-type, 10-20 x 7.0-12 µm, (broadly) clavate, subcylindrical, thin-walled in lower part, slightly thick-walled in upper part, projections slightly thick-walled, subacute or obtuse, nodulose, up to 6.0 x 1.0(-1.5) µm large; thick-walled parts with ochraceous-yellow walls in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, up to 5.0 µm wide hyphae with dark brown walls in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reactions: basidiospores, pileus hyphae non-dextrinoid and inamyloid, stipe medulla and cortex hyphae weakly to distinctly dextrinoid.
Ecology: Saprophytic, growing on dead twigs in hill miombo forest with *Brachystegia glaucescens* and rocky herbless patches with well developed leaf litter layer.

Distribution: Known only from Zimbabwe.

Revised specimens: Zimbabwe: Mvuma, Lovedale Ranch, hill north of road in front of "incubator" – 1930A4, 6 Febr. 1999 leg. A. Verbeken 99-136 (GENT, holotype; BRNM 677246, isotype).

Marasmius lovedalensis is characterised in having distant lamellae, an orange coloured pileus without central papilla (only with a central black dot), rather large and broad basidiospores, large basidia and rather small cheilocystidia and pileipellis cells. It belongs to sect. *Marasmius*.

Marasmius guyanensis Mont. seems to be a very closely related species. However, it has less numerous lamellae (L = 6-10), narrower basidiospores, smaller basidia (20-26 x 8.5-10 µm) and it grows on dead leaves. *Marasmius gordipes* Sacc. & Paol. has an ochraceous brown or reddish brown pileus, a very long stipe (60-130 mm long), and shorter basidiospores (9.5-11 x 4.5-6 µm) (Pegler 1986, Petch 1948); *M. ruforotula* Singer differs especially in having a well-developed central papilla at pileus centre, smaller (8-11 x 4.5-6 µm, resp. 7-9.5 x 4-5 µm) and ellipsoid basidiospores and smaller basidia (20-24 x 6-7 µm) (Pegler 1983, Desjardin & Horak 1997), and *M. dicotyledoneus* (Singer) Singer in having a paler pileus, shorter stipe (4-6 mm) and narrower basidiospores (9.5-12.3 x 3.5-4.7 µm) (Singer 1976).

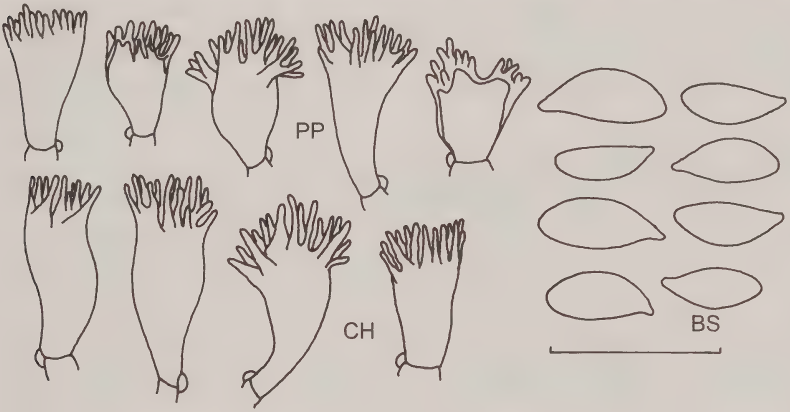

Fig. 5. *Marasmius lovedalensis* (holotype).

Marasmius mulanjensis **Antonín sp. nov.** (Fig. 6)

Pileo usque 2 mm lato, convexo-hemisphaerico vel late conico, striato, (rubro-)brunneo. Lamellis distantibus, L = 7-9, angustis, albidis. Stipite usque 10(-15) mm longo, filiforme, insititio, glabro, apicem pallidiore, ad basim nigro-brunneo. Basidiosporis 6,9-8,2 x 3,8-5,4 µm, ellipsoideis, subamygdaloideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 1) e cellulis cheilocystidiis Marasmii rotalis similibus, 11,5-20 x 8,5-13 µm, clavatis et 2) e cellulis lageniformibus vel fusiformibus, 18,5-31 x 4,6-7,3 µm, tenuitunicatis. Pleurocystidiis similibus cheilocystidiis typi 2. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii rotalis, 14-20 x 8,5-14,5 µm, clavatis vel pyriformibus. Pileocystidiis et caulocystidiis absentibus. Hyphis indextrinoideis, fibulatis. Ad ramos putridos.

HOLOTYPUS: Malawi, Mount Mulanje, 17. XI. 1981 leg. J. Rammeloo 7400 (holotypus in herbario BR 11970-39 asservatur).

Pileus small, up to about 2 mm broad, convex-hemispherical to broadly conical, radially striate, (rusty) brown. Lamellae distant, L = 7-9, l = 0, narrow, ± whitish. Stipe up to 10(-15) mm long, filiform, insititious, paler at apex, black-brown towards base.
Basidiospores 6.9-8.2 x 3.8-5.4 µm, E = 1.7-2.0, Q = 1.8, ellipsoid, subamygdaloid, thin-walled, smooth, hyaline. Basidia 19-23 x 8.5-10 µm, 4-spored, clavate. Basidioles 11-24 x 4.0-9.5 µm, clavate, subcylindrical. Cheilocystidia of two types: 1) broom cells of the Rotalis-type, 11.5-20 x 8.5-13 µm, similar to pileipellis cells, 2) lageniform to subfusoid cells, 18.5-31 x 4.6-7.3 µm, rostrate, thin-walled, sometimes slightly thick-walled at apex. Pleurocystidia similar to cheilocystidia of type 2. Trama hyphae cylindrical, subinflated, thin-walled, mostly smooth, rarely finely incrusted, hyaline, up to 10 µm wide. Pileipellis a hymeniderm of broom-cells of the Rotalis-type, 14-20 x 8.5-14.5 µm, (broadly) clavate, pyriform, thick-walled entirely or in upper part only, rarely entirely thin-walled, projections up to 3.0 x 1.0 µm, obtuse to acute; walls yellow-brown in KOH. Pileocystidia absent. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, diverticulate, up to 6.0 µm wide hyphae with dark yellow-brown to brown walls in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reactions: neither basidiospores nor other tissues dextrinoid or amyloid.
Ecology: Growing on dead hanging branches, probably of *Mumulops* sp.
Distribution: It has so far been collected only in Malawi.
Revised specimens: Malawi: Mount Mulanje, 17 Nov. 1981 leg. J. Rammeloo 7400 (BR 11970-39, holotype).

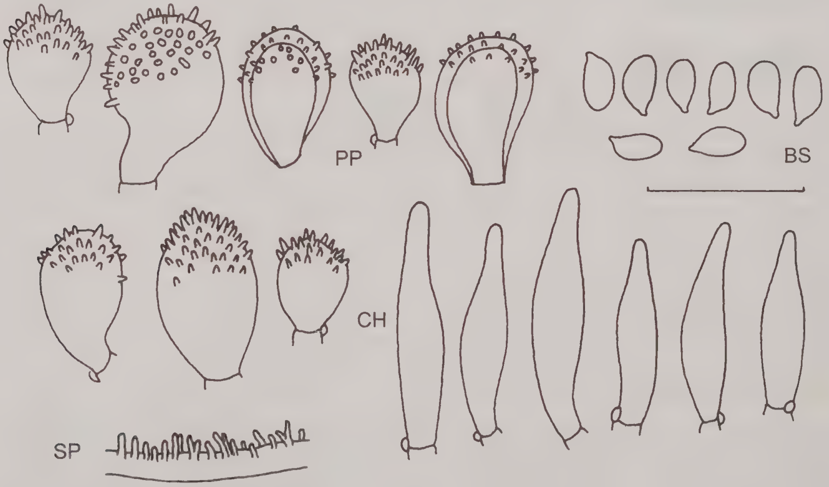

Fig. 6. *Marasmius mulanjensis* (holotype).

Marasmius mulanjensis is characterised in having distant lamellae, rather small basidiospores, two types of cheilocystidia, well-developed pleurocystidia, a diverticulate stipitipellis and by the absence of pileo- and caulocystidia. It belongs to sect. *Hygrometrici*.

It differs from *M. parviconicus* Pegler in having a non-striate pileus, differently shaped basidiospores, two types of cheilocystidia and diverticulate stipitipellis hyphae. The similar

Marasmius corbariensis (Roumeg.) Singer has a bicoloured pileus with darker centre and paler margin, more numerous lamellae (L = 10-14), larger basidia (23-29 x 8.0-9.5 µm) and differently shaped basidiospores. *Marasmius ilicis* Singer has sometimes a striate pileus, only one type of cheilocystidia, and well-developed pileo- and caulocystidia (Singer 1976).

***Marasmius mvumae* Antonín & C. Sharp sp. nov.** (Fig. 7)

Pileo ca 20 mm lato, convexo-applanato, margine regulare vel crenulato, brunneo-luteo-cremeo. Lamellis distantibus, anguste adnatis, albidis. Stipite ca 35 × 3,5 mm, cylindraceo, non-insititio, apicem brunneo-luteo, ad basim brunneo. Basidiosporis 6,0-10,0 x 4,0-5,2 µm, ellipsoideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 13-26 x 9,0-15 µm, clavatis, pyriformibus vel subfusiformibus, tenuitunicatis. Pileipellis hymeniformis, e cellulis clavatis, pyriformibus vel lageniformibus, 15-27 x 11-17 µm, laevibus. Caulocystidiis 13-35 x 7,0-15 µm, clavatis vel cylindraceis, tenui- vel subtiliter crassitunicatis. Hyphis indextrinoideis, fibulatis. Ad folia putrida.
HOLOTYPUS: Zimbabwe, Midlands Province, Mvuma, Beacon Hill Plots, 9. I. 1997 leg. C. Sharp 1213/99 (holotypus in herbario BR 152505-21 asservatur).

Pileus about 20 mm broad, plano-convex, with regular or irregular, sometimes crenulate margin, matt, buff cream coloured. Lamellae shortly adnate, distant, firm, white. Stipe about 35 x 3.5 mm, cylindrical, central, firm, matt, buff coloured at apex, fulvous and then sienna towards base. Context strongly acrid.
Basidiospores 6.0-10.0 x 4.0-5.2 µm, E = 1.5-2.1, Q = 1.7-1.9, ellipsoid, ± thin-walled, smooth, hyaline; thick-walled “resting” spores present. Basidia 24-31 x 8.0-9.0 µm, 4-spored, clavate. Basidioles 15-33 x 3.5-9.0 µm, clavate to cylindrical. Cheilocystidia 13-26 x 9.0-15 µm, clavate, pyriform or subfusoid, thin-walled, hyaline. Pleurocystidia absent. Hyphae cylindrical to subinflated, thin-walled, smooth, up to 12 µm wide. Pileipellis a hymeniderm, made up of 15-27 x 11-17 µm, clavate, pyriform, lageniform, thin-walled cells. Pileocystidia absent. Stipitipellis a cutis, of cylindrical, parallel, slightly thick-walled, up to 8 µm wide hyphae. Caulocystidia 13-35 x 7.0-15 µm, adpressed to erect, clavate to cylindrical, obtuse, thin- to slightly thick-walled. Clamp-connections present in all tissues. Chemical reactions: neither basidiospores nor other tissues dextrinoid or amyloid.
Ecology: Caespitose, on thick leaf litter in miombo woodland, under *Brachystegia glaucescens*.
Distribution: Known only from the type locality in Zimbabwe.
Revised specimens: Zimbabwe: Mvuma, Midlands Province, Beacon Hill Plots, 1930 A4, 29 Dec. 1996 leg. C. Sharp 483/96 (BR 152504-20). – ditto, 9 Jan. 1997 leg. C. Sharp 1213/99 (BR 152505-21, holotype).

Marasmius mvumae is characterised in having ± buff coloured caespitose carpophores, rather small basidiospores, well-developed cheilo- and caulocystidia and by the absence of pileo- and pleurocystidia. It belongs to sect. *Chordales*.

Among similar species, *M. amabilis* Har. & Pat., with about the same size and colour of carpophores, has distinctly larger basidiospores (e.g. 26.5 x 6.5 µm, Desjardin & Horak 1997); *M. oligocystis* Singer is smaller (pileus 6 mm broad), with small basidiospores (5.3-6 x 2.3-3 µm); *M. aimara* Singer has a pale golden cinnamon coloured pileus and stipe and smaller basidiospores (5.4-5.6 x 4.3 µm) (Singer 1976).

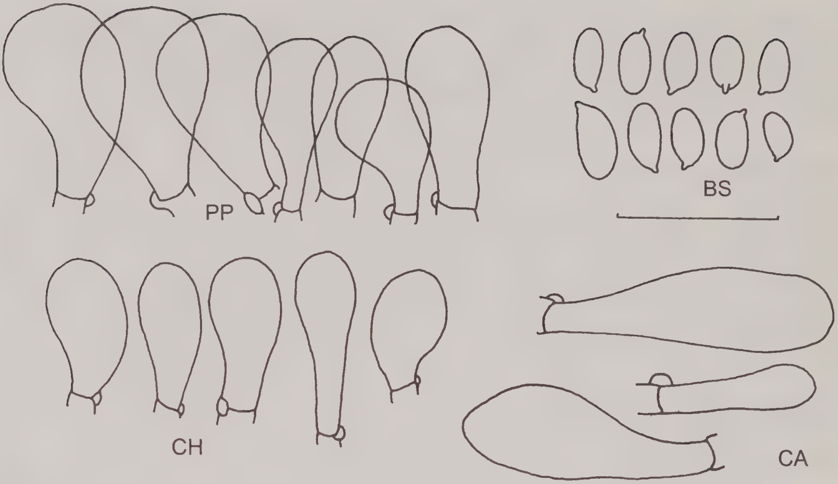

Fig. 7. *Marasmius mvumae* (holotype).

Marasmius schreursii Antonín sp. nov. (Fig. 8)

Pileo 22 mm lato, convexo, dein convexo-applanato, cum centro late papillato, margine striato, hygrophano, glabro, griseo-brunneo vel luteolo-griseolo. Lamellis distantibus, L = ± 15, l = 2-3, late adnatis vel emarginatis, latis, ventricosis, albidis vel griseolis. Stipite 18-22 × 1,5-2,5 mm, cylindraceo, non-insititio, tomentoso, apicem albido, ad basim pallide griseo. Basidiosporis (8,5-)9,0-11,2 x 3,1-4,0(-4,4) µm, anguste ellipsoideis, cylindraceo-ellipsoideis vel sublacrymoideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 21,5-34,5 x 10-19 µm, late clavatis, pyriformibus, tenui- vel subtiliter crassitunicatis. Pleurocystidiis 20-40 x 4,0-6,2 µm, anguste clavatis, fusiformibus vel sublageniformibus. Pileipellis hymeniformis, e cellulis clavatis, vesiculosis vel pyriformibus, 10-27 x 6,2-19 µm, laevibus. Caulocystidiis 19-80 x 3,8-14 µm, cylindraceis, anguste clavatis, subfusiformibus, regularibus, irregularibus vel furcatis, subtiliter crassitunicatis. Hyphis indextrinoideis, fibulatis. Ad lignum putridum.
HOLOTYPUS: Democratic Republic of Congo, Katanga Province, Luiswishi, 6. II. 1986 leg. J. Schreurs 1038 (holotypus in herbario BR 7881-24 asservatur)

Pileus 22 mm broad, convex to plano-convex, obtuse or with a low broad papilla at centre, slightly striate at margin, smooth, hygrophanous, pale grey-brown to beige coloured, more distinctly grey when wet. Lamellae distant, L = ± 15, l = 2-3, broadly adnate to emarginate with a small tooth, rather broad, ventricose, whitish or greyish, edge concolorous or yellowish. Stipe slightly to distinctly eccentric, 18-22 x 1.5-2.5 mm, cylindrical, broadened above, tomentose, whitish, pale greyish towards base.
Basidiospores (8.5-)9.0-11.2 x 3.1-4.0(-4.4) µm, E = 2.1-3.2, Q = 2.7, narrowly ellipsoid, cylindrical-ellipsoid to sublacrymoid, thin-walled, hyaline. Basidia 27-34.5 x 5.8-8.0 µm, 4-spored, clavate. Basidioles 15-35 x 3.3-7.0 µm, clavate, cylindrical or subfusoid. Cheilocystidia 21.5-34.5 x 10-19 µm, broadly clavate, pyriform, sometimes capitate, thin- or slightly thick-walled. Pleurocystidia 20-40 x 4.0-6.2 µm, narrowly clavate, narrowly fusoid,

sublageniform, often (sub)rostrate, thin-walled. Hyphae cylindrical to subinflated, thin- to slightly thick-walled, up to 16 µm wide; mixed with thick-walled, narrow ones. Pileipellis a hymeniderm, made up of 10-27 x 6.2-19 µm, clavate, pyriform to vesiculose, slightly to distinctly thick-walled, often irregular cells, pale greyish brownish in KOH. Stipitipellis a cutis of parallel, cylindrical, slightly thick-walled, up to 7.0 µm wide hyphae. Caulocystidia 19-80 x 3.8-14 µm, cylindrical, narrowly clavate, subfusoid, sublageniform, sometimes irregular or furcate, slightly thick-walled. Clamp-connections present in all tissues. Chemical reactions: neither basidiospores nor other tissues dextrinoid or amyloid.

Ecology: On dead wood in a "forêt dense".

Distribution: Known only from the Democratic Republic of Congo.

Revised specimens: Democratic Republic of Congo: Katanga Province, Luiswishi, 6 Febr. 1986 leg. J. Schreurs 1038 (BR 7881-24, holotype).

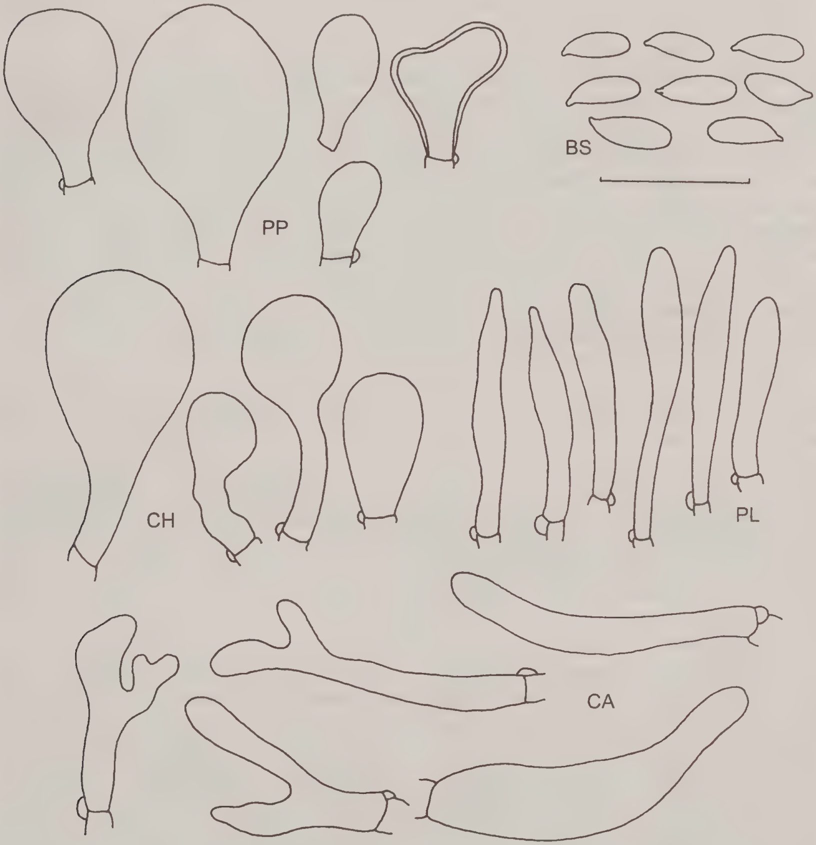

Fig. 8. *Marasmius schreursii* (holotype).

Marasmius schreursii is characterised in having narrowly ellipsoid to cylindrical-ellipsoid spores, and by the presence cheilo-, pleuro- and caulocystidia, and dimitic hyphae. It belongs to sect. *Chordales*.

Marasmius notandus Corner described from Borneo (Corner 1996) seems to be a closely related species. In comparison with Corner´s description, it differs in having an umber brown pileus, a robust (up to 40 x 8 mm) and at base bulbose stipe with only finely white pruinose stipe surface, longer pleurocystidia (50-70 x 7-10 µm) and clampless hyphae. *Marasmius batistae* Singer (Singer 1976) with a similar pileus colour, has smaller basidiospores (5.5-8.8 x 2.5-3.8 µm), smaller basidia (18-25 x 4.3-5.0 µm), no cystidia and hyaline pileipellis cells; all species having cystidia described in Singer (1976) have smaller or broader spores.

***Marasmius somalomoensis* Antonín sp. nov.** (Fig. 9)

Pileo 1-5 mm lato, convexo, dein convexo-plano, cum centro depresso et juventute papillato, margine crenulato, sulcato, subtiliter tomentoso, pallide brunneo vel brunneo-aurantiaco, cum centro obscure brunneo. Lamellis collariatis, L = 11-13, late adnatis, nonnumquam intervenosis, albidis vel pallide aurantiaco(-griseo). Stipite 10-17 x 0,1-0,2 mm, filiforme, insititio, glabro, apicem pallidiore, ad basim nigro-brunneo. Basidiosporis 7,0-10,0(-11) x 3,7-5,5 µm, ellipsoideis, ellipsoideo-fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis (raro bisporis). Cheilocystidiis e cellulis typo Marasmii rotalis similibus, 14-30(-40) x 8,0-18(-22) µm, clavatis, hyalinis, subtiliter crassitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii rotalis, 18-33 x 10-19 µm, clavatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite dextrinoideis. Ad folia putrida.
HOLOTYPUS: Cameroon, Sud Province, Somalomo, Dja Biosphere Reserve, 8. IV. 2001 leg. V. Antonín Cm 01.42 (holotypus in herbario BRNM 666108 asservatur).

Pileus 1-5 mm broad, convex, then low-convex, depressed at centre, with a small central papilla when young, without it when old, crenulate at margin, striate up to the centre, finely tomentose, light brown to brownish orange (6D4-5, 6C5), slightly darker, almost dark brown at central papilla, sometimes with a white zone around the papilla when dry. Lamellae moderately distant, L = 11-13, l = 0(-1), collariate, broadly adnate, rather broad, sometimes intervenose, whitish to pale orange (greyish) (4-5A2, 5B3), with concolorous edge. Stipe 10-17 x 0.1-0.2 mm, filiform, insititious, lustrous, twisted, concolorous with lamellae at apex, through dark brown to black brown towards base; sterile stipes present. Context membranaceous.
Basidiospores 7.0-10.0(-11) x 3.7-5.5 µm, E = 1.6-2.1, Q = 1.7-1.9, ellipsoid, ellipsoid-fusoid, thin-walled, smooth, hyaline. Basidia 20-28 x 8.0-8.5 µm, 4- (rarely 2-)spored, clavate. Basidioles 15-28 x 4.0-10 µm, clavate, fusoid, cylindrical. Cheilocystidia shaped as broom-cells of the Rotalis-type, 14-30(-40) x 8.0-18(-22) µm, (broadly) clavate, thin-walled, hyaline, with slightly thick-walled, up to 3.0 x 1.5 µm large projections; mixed with scattered similar but smooth clavate cells. Pleurocystidia absent. Trama hyphae cylindrical to subinflated, smooth to minutely incrusted, branched, up to 12 µm wide. Pileipellis a hymeniderm of broom-cells of the Rotalis-type, 18-33 x 10-19 µm, entirely thin- to very slightly thick-walled, hyaline, dirty yellow to (ochraceous) brown in thick-walled parts, with up to 3.0 x 1.5 µm large, slightly thick-walled warts with the same wall colour. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, smooth, up to 6.0 µm wide cells, with brown walls in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reactions:

basidiospores, pileus and lamellar trama hyphae non-dextrinoid and inamyloid, stipe medulla and cortex hyphae dextrinoid.

Ecology: Saprophytic, growing on dead leaves.

Distribution: Known only from Cameroon.

Revised specimens: Cameroon: Sud Province, Somalomo, Dja Biosphere Reserve, 8 Apr. 2001 leg. V. Antonín Cm 01.42 (BRNM 666108, holotype). – ditto, 10 Apr. 2001 leg. V. Antonín Cm 01.79 (BRNM 666145). – ditto, 11 Apr. 2001 leg. V. Antonín Cm 01.91 (BRNM 666085). – Democratic Republic of Congo: Kivu, Irangi, 19 Apr. 1972 leg. J. Rammeloo JR Z334 (GENT).

Marasmius somalomoensis is characterised in having a distinctly brown to brownish orange pileus, moderately distant lamellae, rather large basidiospores and large basidia and basidioles. It belongs to sect. *Marasmius*.

The closest species seems to be *M. rotalis* Berk. & Broome. It differs by a white or whitish to cream (when fresh), then pale beige pileus with beige to grey-brown central papilla, more numerous lamellae (L = 13-17), slightly narrower basidiospores (7.0-10.0 x 3.5-4.5 µm) and smaller cheilocystidia (17-19 x 7.0-9.0 µm). *Marasmius tubularis* Petch has a greyish brown pileus with white margin and black central papilla, less numerous lamellae (L = 8-12) with coloured edge and smaller cheilocystidia (12-16 x 8-11 µm, Pegler 1986); *M. plicatus* Wakker has a pileus with an off-white umbilicus without papilla, less numerous lamellae (L = 7-8) and slightly larger basidiospores (9-11 x 4-6 µm, Desjardin & al. 2000); *M. arimanus* Dennis has a sepia or mummy brown pileus, less numerous lamellae (L = 7) and longer and narrower basidiospores, 11-14 x 3.5-4 µm; *M. dodecaphyllus* Singer has a pileus with a flat central grey dot, less numerous lamellae (L = 12), an umber brown stipe, and smaller basidiospores (7.5-8.2 x 3-4.5 µm); *M. platyspermus* Singer has at first a whitish, then a yellow beige pileus with a black central papilla, more numerous lamellae (L = 13-20) and grows on twigs and wood, and *M. tereticeps* Singer has a cinnamon ochraceous pileus with black central papilla, extraordinarily broad lamellae and narrower basidiospores (8.2-11.2 x 3.5-4 µm) (all cf. Singer 1976).

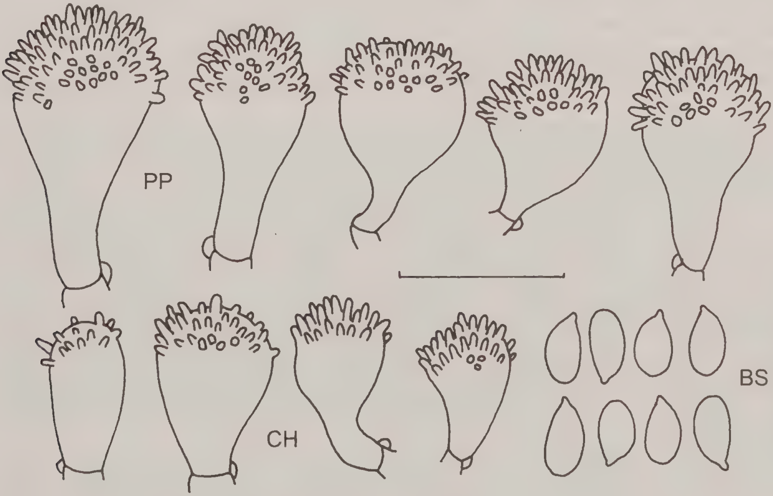

Fig. 9. *Marasmius somalomoensis* (holotype).

***Marasmius staudtii* var. *magnisporus* Antonín sp. nov.** (Fig. 10)

A varietate typica basidiosporis magnis: 32-44 x 5.5-7.5 µm, pleurocystidiis brevibus (35-50 x (8.5-)12-25(-28) µm) et hyphis stipitis cum KOH olivaceo coloratis differt.
HOLOTYPUS: Democratic Republic of Congo, Kivu Province, Irangi, IV. 1972 leg. J. Rammeloo JR Z390 (holotypus in herbario GENT asservatur).

Pileus 22-42 mm broad, convex to campanulate, strongly sulcate, crenulate at margin, glabrous, membranaceous, always in vilaceous colour, reddish grey, brownish grey to dull red (11B2, 11C2-3), greyish Magenta to dark purple (14D-F5-6) at centre and on sulci, yellowish white to pale yellow (3A2-3) or pale violaceous (greyish ruby, 12B-C3) in striae. Lamellae distant, L = c. 18-30, l = 1-2, narrowly adnate to free, not intervenose, yellowish white (3A2), with concolorous, entire edge. Stipe 60-130 x 1-2 mm, cylindrical or compressed, slightly broadened at base (2 mm), glabrous, hollow, twisted-grooved in upper part, black-brown towards base, paler, brown (7D6) at apex; with a rich basal mycelium. Context white, with indistinct smell and slightly bitter taste.
Basidiospores 32-44 x 5.5-7.5 µm, E = 4.8-6.8, Q = 5.9, narrowly clavate, narrowly fusoid, thin-walled, hyaline. Basidia 27-41 x (8.5-)10-17 µm, 4-spored, clavate or subutriform. Basidioles 18.5-45.5 x 4.4-17 µm, clavate, cylindrical. Cheilocystidia 24-35(-42.5) x (8.5-)10-13.5(-17) µm, clavate, often capitate, thin-, rarely slightly thick-walled. Pleurocystidia 35-50 x (8.5-)12-25(-28) µm, broadly clavate, clavate, vesiculose or fusoid, thin-walled, with refractive contents. Hyphae of cylindrical, subinflated to fusoid cells, branched or with lateral projections (especially in pileus), thin- to slightly thick-walled, up to 15.5 µm wide. Pileipellis a hymeniderm, made up of 17-35 x (9.2-)12-19 µm, clavate to vesiculose, sometimes pyriform, thin- to slightly thick-walled smooth cells, with subhyaline to pale greyish-brownish walls in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, up to 7 µm wide hyphae, olivaceous green in KOH. Caulocystidia absent. Clamp-connections present in all tissues. Chemical reaction: basidiospores and hymenium non-dextrinoid; hyphae and pileipellis cells dextrinoid.
Ecology: Single, probably on twigs in a dense leaf humus layer, in a primary rain forest.
Distribution: Known only from the Democratic Republic of Congo.
Revised specimens: Democratic Republic of Congo: Kivu Province, Irangi, Apr. 1972 leg. J. Rammeloo JR Z390 (holotype) and Z390a (both GENT).

This variety is characterised in having a violaceous to dark purple pileus with pale stripes, very large basidiospores, rather small pleurocystidia and stipitipellis hyphae with olivaceous green walls in KOH. It belongs to sect. *Globulares*.

M. staudtii Henn. var. *staudtii* differs in having smaller basidiospores (20-)22.5-28.5 x 4.5-6.0 µm large and smaller cheilocystidia (15-26 x 7.5-11 µm). *Marasmius zenkeri* Henn. differs by violaceous tinged lamellae, the absence of pleurocystidia and smaller basidiospores [(15.5-)17.7-23.1 x 4.2-5.6 µm]; *M. musisporus* Desjardin & E. Horak differs in having a smaller (8-25 mm), greyish lilac pileus with yellow ridges, greyish lilac lamellae, smaller stipe (50-70 mm long), narrower basidiospores (30-40 x 4.5-5.0 µm), smaller cheilocystidia (15-25 x 8-14 µm) and by the absence of pleurocystidia; *M. purpureostriatus* Hongo has more distant lamellae (L = 10-13), smaller basidiospores (19-28(-32) x 4-6 µm), smaller cheilocystidia (15-37 x 10.0-15 µm), broadly clavate caulocystidia and no pleurocystidia (isotype ZT!).

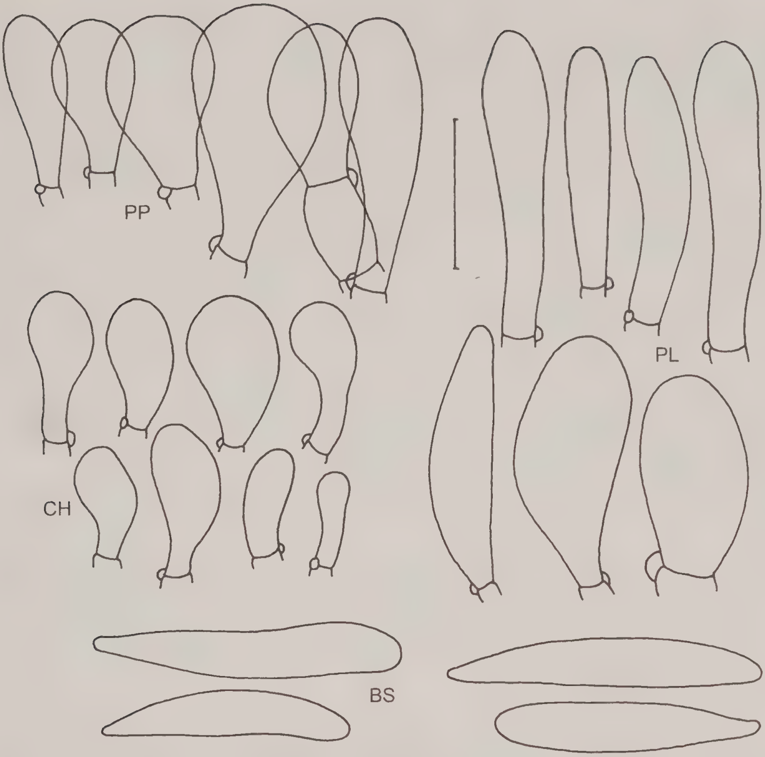

Fig. 10. *Marasmius staudtii* var. *magnisporus* (holotype).

Setulipes afibulatus Antonín sp. nov. (Fig. 11)

Pileo 5-6 mm lato, convexo, membranaceo, subtiliter farinaceo, ruguloso, luteolo-griseo. Lamellis, L = ± 11, tenuibus, albidis. Stipite 20-30 x usque 1 mm, filiforme, cylindraceo, subtiliter pruinoso (lens) in apice albido, ad basim obscure brunneo. Basidiosporis (6,9-)8,0-10,4 x 3,5-4,8 µm, ellipsoideis vel lacrymoideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cellulis typo Marasmii sicci similibus, (8,0-)16-35 x 7,0-15,5 µm, clavatis vel cylindraceis. Pileipellis e hyphis cylindraceis, incrustatis, hyphis Marasmielli rameali similibus constructa. Caulocystidiis (4,0-)14-65 x 2,3-6,6(-9,2) µm, cylindraceis, subtiliter irregularibus, crassitunicatis, hyalinis vel pallide flavidis. Hyphis stipite indextrinoideis vel subtiliter dextrinoideis, efibulatis. Ad folia putrida.
HOLOTYPUS: Malawi, Nyika National Park, Gîte Chelinda, 4. XII. 1981 leg. J. Rammeloo 7652 (holotypus in herbario BR 11989-58 asservatur).

Pileus 5-6 mm broad, convex, membranaceous, finely powdery, radially rugulose, pale beige, paler towards margin. Lamellae moderately close, L = ± 11, lamellulae present, attached to a false collarium, narrow (about 1 mm), not intervenose, pale, whitish, with concolorous, finely

pubescent edge. Stipe 20-30 x up to 1 mm, filiform, cylindrical, smooth, finely pruinose (lens), concolorous with lamellae at apex, dark brown (± 8F5) towards base.

Basidiospores (6.9-)8.0-10.4 x 3.5-4.8 µm, E = 1.9-2.4, Q = 2.0-2.4, ellipsoid, lacrymoid-ellipsoid, thin-walled, smooth, hyaline. Basidia 19-27(-35) x 8.5-10.0 µm, 4-spored, clavate. Basidioles 11-27 x 4.5-11 µm, clavate, cylindrical or subfusoid. Cheilocystidia (8.0-)16-35 x 7.0-15.5 µm, shaped as broom-cells of the Siccus-type, cylindrical to clavate, thin-walled or slightly thick-walled at least in upper part, with scattered to numerous digitate, obtuse, curved or nodulose, sometimes branched projections. Trama hyphae cylindrical, thin-walled, hyaline, up to 7.0 µm wide. Pileipellis a cutis of ± radially arranged, thin- to slightly thick-walled, often incrusted, up to 8.0 µm wide hyphae with well-developed Rameales-structure, mixed with scattered 11-14 x 3.8-4.6 µm large broom-cells or coralloid cells, with pale ochraceous walls in KOH, projections up to 5.0 x 0.5-1.0 µm large. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, up to 5.5 µm wide hyphae, with yellow-ochraceous walls in KOH. Caulocystidia (4.0-)14-65 x 2.3-6.6(-9.2) µm, cylindrical, sometimes subrostrate, slightly irregular, obtuse, thick-walled (up to 1.5 µm), sometimes branched or with lateral projections, sometimes in the form of lateral outgrowths, with hyaline or slightly yellowish walls in KOH. Clamp-connections absent. Chemical reactions: basidiospores and trama hyphae non-dextrinoid, stipe medulla hyphae non-dextrinoid or weakly dextrinoid.

Ecology: Saprophytic, growing gregariously on dead leaves.

Distribution: It has so far been collected in Burundi, the Democratic Republic of Congo and Malawi.

Revised specimens: Burundi: Bururi Province, Kigwena, Kigwena forest, 22 Feb. 1979 leg. J. Rammeloo 6717 (BR 11948-17). – ditto, 20 Feb. 1979 leg. J. Rammeloo 6672 (BR 11940-09). – Democratic Republic of Congo: Katanga Province, Plateau de Biano, Mengé, 1 Apr. 1986 leg. J. Schreurs 1555 (BR 8313-68). – Malawi: Nyika National Park, Gîte Chelinda, 4 Dec. 1981 leg. J. Rammeloo 7652 (BR 11989-58, holotype). – ditto, 6 Dec. 1986 leg. J. Rammeloo 7695 (BR 11992-61).

Setulipes afibulatus is characterised in having a small, pale beige coloured pileus, dark brown stipe, cheilocystidia shaped as Siccus-type broom-cells, a pileipellis with well-developed Rameales-structure mixed with broom-cells, cylindrical caulocystidia sometimes branched or with lateral projections and no clamp-connections.

Among species without clamp-connections, *Marasmius aurantiobasalis* Desjardin & E. Horak has a golden yellow glabrous stipe, smaller, (6-)7-9 x 3-4(-4.6) µm large basidiospores and no caulocystidia; it has sometimes clamps developed at the base of basidia. *Marasmius straminipes* Peck var. *straminipes* has a light brown to pale greyish brown pileus with greyish orange or pale greyish orange margin, a stramineous or brownish orange glabrous stipe, smaller basidiospores (6.5-9.5 x 3.2-4.5 µm) and no caulocystidia (Desjardin & Petersen 1989b); *M. dysodes* Singer has cheilocystidia of the Rotalis-type; *M. atroincrustatus* Singer var. *inodorosus* Singer has a cinnamomeo-alutaceous pileus and smaller basidiospores (6.5-7.5 x 3.5-4 µm); *M. atlanticus* Singer has a reddish brown pileus at centre with whitish margin and smaller basidiospores (7.5-8 x 3.3 µm); *M. eorotula* Singer has a white pileus, a white, at base stramineous stipe and smaller, (5.5-)6.5-8 x 2.5-3 µm large basidiospores; *M. defibulatus* Singer has a whitish pileus and smaller basidiospores (6-9 x 3.2-4.5 µm), and *M. tomentellus* Berk. & M.A. Curtis has a fulvous to vinaceous brown pileus and larger basidiospores (11-11.5 x 4-5 µm) (Singer 1976).

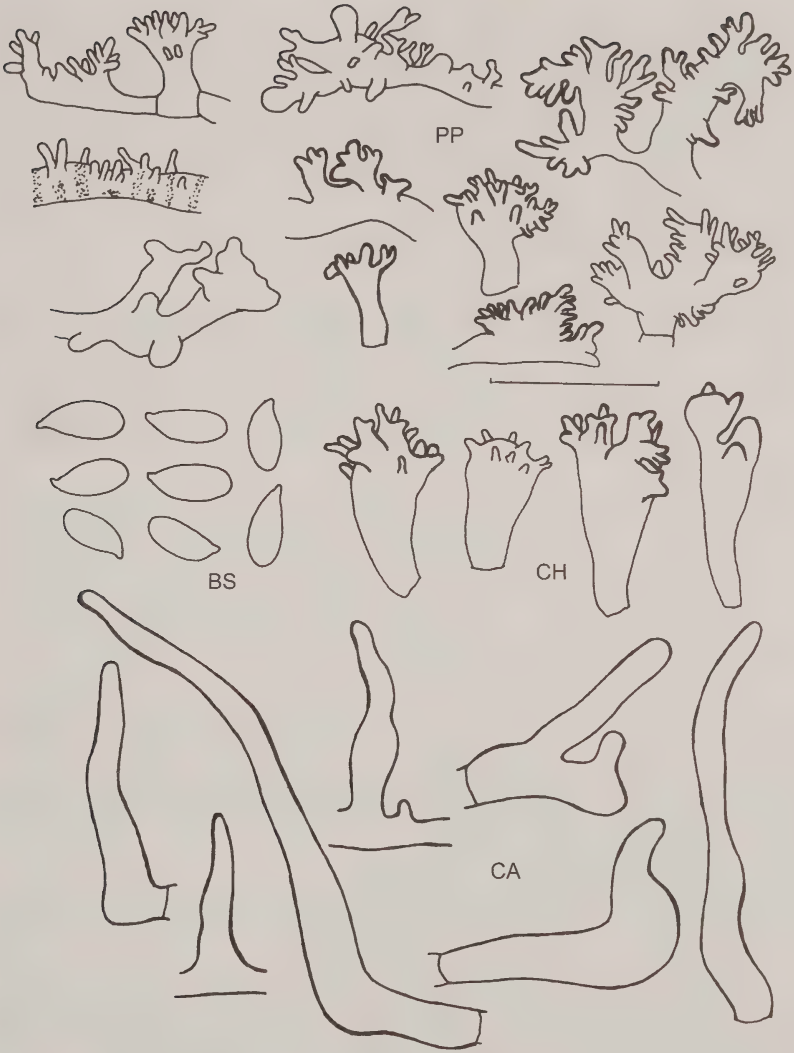

Fig. 11. *Setulipes afibulatus* (holotype).

Setulipes brevistipitatus **Antonín sp. nov.** (Fig. 12)

Pileo 2-4 mm lato, convexo, centro subtiliter depresso et juventute papilloso, margine crenulato, plicato, subtiliter tomentoso, brunneo. Lamellis distantibus, L = 7-9, late adnatis, pileo concolororibus, acie concolore et subtiliter fimbriata. Stipite 2-3 mm longo, filiformi,

curvato, subinsititio, flocculoso, apice pallidee brunneo, basin versus obscure brunneo. Rhizomorphis praesentibus. Basidiosporis 7,0-9,0 x 2,5-3,7 µm, cylindraceo-ellipsoideis vel ellipsoideo-fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis 17-21(-30) x 6,0-12 µm, clavatis, coralloideis vel cum projectionibus apicalibus, tenuitunicatis. Pileipellis e hyphis cylindraceis, tenui- vel crassitunicatis, glabris vel incrustatis, usque 10 µm latis. Caulocystidiis 20-40 x 4,5-9,0 µm, cylindraceis vel clavatis, irregularibus, cum projectionibus apicalibus vel coralloideis. Hyphae stipitis indextrinoideae vel subtiliter dextrinoideae, fibulatae. Ad ramos putridos.

HOLOTYPUS: Cameroon, Sud Province, Somalomo, Dja Biosphere Reserve, 11. IV. 2001 leg. V. Antonín Cm 01.89 (holotypus in herbario BRNM 666083 asservatur).

Pileus 2-4 mm broad, convex, slightly depressed at centre with very small and less distinct papilla when young, papilla absent when old, crenulate at margin, plicate, striate, slightly tomentose, uniformly brown (7D5). Lamellae distant, L = 7-9, l = 0-1, broadly adnate, sometimes with false small adpressed pseudocollarium, rather broad, sometimes furcate, concolorous with pileus, with concolorous, pubescent edge. Stipe 2-3 mm long, filiform, curved, slightly broadened at base, subinsititious, entirely flocculose, strigose towards base, dark brown (7F7) towards base, paler (± concolorous with lamellae) at apex, black rhizomorphs present.

Basidiospores 7.0-9.0 x 2.5-3.7 µm, E = 2.2-3.0, Q = 2.7, cylindrical-ellipsoid, ellipsoid-fusoid, thin-walled, hyaline, smooth. Basidia 18-21 x 6.5-8.0 µm, 4-spored, clavate. Basidioles 13-20 x 3.0-7.0 µm, cylindrical, clavate, fusoid. Cheilocystidia 17-21(-30) x 6.0-12 µm, clavate, with apical projections or coralloid, rarely lobate, thin-walled, sometimes with one septum. Pleurocystidia absent. Trama hyphae cylindrical, thin- and slightly thick-walled, smooth or incrusted, up to 10 µm wide. Pileipellis a cutis of radially arranged, ± cylindrical or slightly inflated, 2-10 µm wide hyphae, with scattered diverticulae, branched, thin- or slightly thick-walled, mostly incrusted, with brown to brown-black incrustation in KOH. Stipitipellis a cutis of cylindrical, parallel, thick-walled, smooth or incrusted, up to 6.0 µm wide hyphae, with dark brown to black-brown walls in KOH. Caulocystidia mostly in groups, 20-40 x 4.5-9.0 µm, adpressed to erect, cylindrical to clavate, irregular, with apical projections or coralloid, slightly thick-walled, with pale to dark brown walls in KOH. Clamp-connections present. Chemical reactions: basidiospores and trama hyphae non-dextrinoid, stipe medulla hyphae non-dextrinoid or weakly dextrinoid.

Ecology: Saprophytic, growing on dead liana stem.

Distribution: It has been collected in Cameroon only.

Revised specimens: Cameroon: Sud Province, Somalomo, Dja Biosphere Reserve, 11 Apr. 2001 leg. V. Antonín Cm 01.89 (BRNM 666083, holotype).

Setulipes brevistipitatus is characterised in having small carpophores with a uniformly brown coloured pileus, a short curved stipe, well developed rhizomorphs, clavate cheilocystidia with apical projections, pileipellis hyphae with scattered diverticulae and cylindrical to clavate caulocystidia with apical projections or coralloid in shape.

Setulipes curvistipitatus Antonín differs in having more robust carpophores, with a paler coloured pileus, different basidiospores, cheilocystidia shaped as Rotalis-type broom-cells and different caulocystidia. *Marasmius brevipes* Berk. & Ravenel forms carpophores often directly on rhizomorphs, has longer basidiospores, 6.4-10(10.8) x 3-5 µm, and no stipe vesture (Desjardin & Petersen 1989a); *Marasmius otagoensis* G. Stev. differs in having a distinctly larger pileus (10-35 mm), more numerous lamellae (L = 16-20), a larger stipe (7-30 x 1-2 mm), smaller basidiospores, 4-5.5(-6.5) x 2.0-3.0 µm and a different pileipellis (Desjardin & Horak 1997).

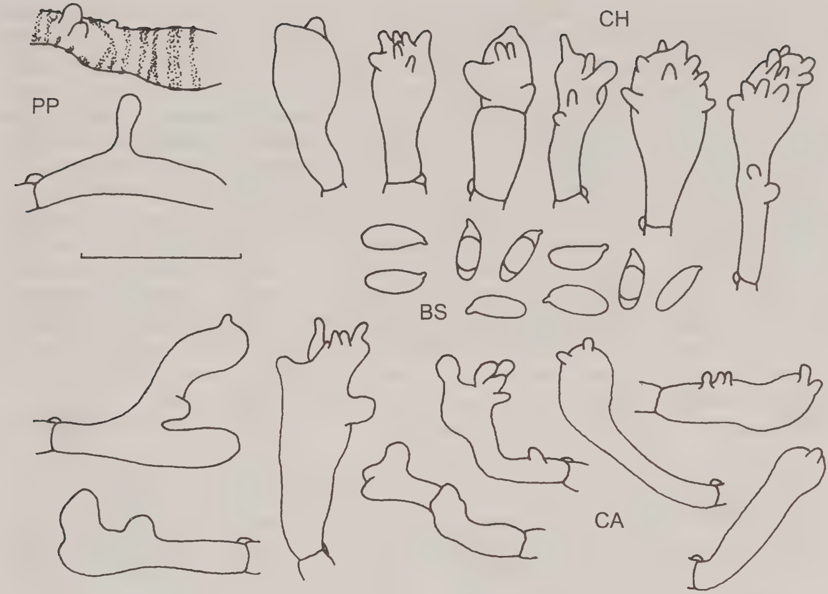

Fig. 12. *Setulipes brevicystidiatus* (holotype).

Setulipes curvistipitatus Antonín sp. nov. (Fig. 13)

Pileo 5-11 mm lato, subtiliter convexo, late papillato, ruguloso, membranaceo, subtiliter granuloso, pallide luteolo-griseo, pallescente. Lamellis distantibus, L = 6-9, l = 0-2, adnatis, nonnumquam intervenosis, pallide luteolo-griseis, acie concolore. Stipite 3-5 × 0,3-1 mm, cylindraceo, curvato, insititio, puberulo, glabro, apice brunneo, basin versus obscure brunneo vel nigro. Basidiosporis 6,2-9,2 x 3,1-4,0(-4,6) µm, ellipsoideis, subamygdaloideis vel (sub)fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typi Marasmii rotalis, 19-39 x 10-25 µm, clavatis vel (sub)vesiculosis, tenuitunicatis. Pileipellis e hyphis cylindraceis, hyphis Marasmielli rameali similibus, constructa. Caulocystidiis 34-68 x 6,2-11,5 µm, cylindraceis vel clavatis, nonnumquam irregularibus, glabris vel incrustatis, nonnumquam cum projectionibus digitatis. Hyphis fibulatis, in stipite indextrinoideis vel subtiliter dextrinoideis. Ad ramos putridos.
HOLOTYPUS: Burundi, Bururi Province, Siguyaye valley, 2. II. 1979 leg. J. Rammeloo 6474 (holotypus in herbario BR 11921-87 asservatur).

Pileus 5-11 mm broad, slightly convex, with broad low papilla, with entire margin, slightly radially rugulose, membranaceous, slightly granulose, not hygrophanous, pale beige-brown (paler than 5C4, 5D5), then pallescent to very pale beige. Lamellae adnate, distant, L = 6-9, l = 0-2, sometimes intervenose and branched, very pale beige (4A2), with concolorous edge. Stipe 3-5 x 0.5-1 mm, cylindrical, curved, finely pubescent, brown (± 5E5) at apex, dark brown to black towards base. Context with slightly fungoid smell and indistinct taste.

Basidiospores 6.2-9.2 x 3.1-4.0(-4.6) µm, E = 1.7-2.3, Q = 2.0-2.1, ellipsoid, subamygdaliform, subfusoid, thin-walled, hyaline, smooth. Basidia 21.5-25.5 x 6.2-8.5 µm, 4-spored, clavate. Basidioles 12-30 x 3.0-7.7 µm, clavate, cylindrical or subfusoid. Cheilocystidia shaped as broom-cells of the Rotalis-type, 19-39 x 10-25 µm, broadly clavate, subvesiculose, thin-walled, with wart-like to digitate, obtuse projections. Pleurocystidia absent. Trama hyphae ± cylindrical, thin- to slightly thick-walled, hyaline, up to 8.0 µm wide. Pileipellis a cutis with well-developed Rameales-structure, hyphae thin- to slightly thick-walled, up to 8.0(-15) µm wide, with coralloid to diverticulate terminal cells or with scattered broom-cells; projections obtuse, digitate, thin- to slightly thick-walled, up to 4.0 µm long; thick-walled parts and incrustation ochraceous-brown in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, up to 5.0 µm wide hyphae, with scattered diverticulae. Caulocystidia 34-68 x 6.2-11.5 µm, adpressed to suberect, cylindrical to clavate, sometimes irregular, thin-to slightly thick-walled, smooth or incrusted, often with up to 4.0 µm long, obtuse, digitate projections. Clamp-connections present. Chemical reactions: basidiospores and pileus trama non-dextrinoid, some stipe medulla hyphae dextrinoid.

Ecology: Saprophytic, growing gregariously on hanging dead twigs of a liana.

Distribution: It has been collected in Burundi only.

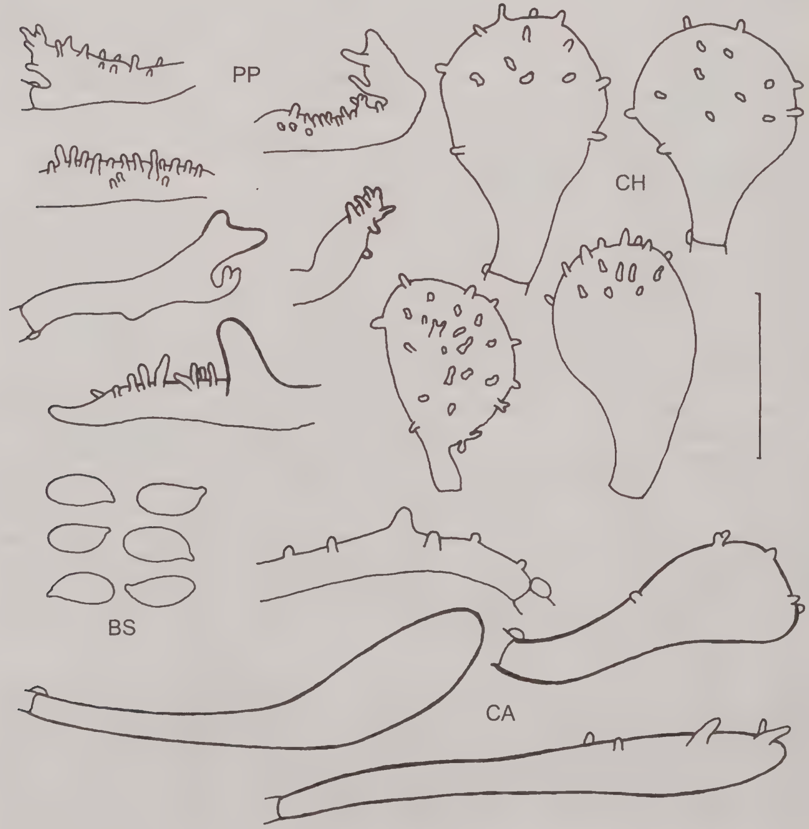

Fig. 13. *Setulipes curvistipitatus* (holotype).

Revised specimens: Burundi: Bururi province, Siguyaye valley, W from Mutambara-Bururi road, 3 Feb. 1979 leg. J. Rammeloo 6508 (BR 11925-91). – ditto, 2 Feb. 1979 leg. J. Rammeloo 6474 (BR 11921-87, holotype).

Setulipes curvistipitatus is characterised in having small carpophores with a pale coloured pileus, intervenose lamellae and a short curved stipe, rather small basidiospores, cheilocystidia shaped as broom-cells of the Rotalis-type and by the presence of caulocystidia.

Setulipes brevistipitatus Antonín differs in having less robust carpophores, a darker coloured pileus, different basidiospores, cheilocystidia and caulocystidia; *Marasmius brevipes* Berk. & Ravenel forms carpophores often directly on rhizomorphs, its basidiospores are longer, 6.4-10(10.8) x 3-5 µm, and has no stipe vesture (Desjardin & Petersen 1989a). *Marasmius otagoensis* G. Stev. differs in having a distinctly larger pileus (10-35 mm), more numerous lamellae (L = 16-20), a larger stipe (7-30 x 1-2 mm), smaller basidiospores, 4-5.5(-6.5) x 2.0-3.0 µm and different pileipellis (Desjardin & Horak 1997).

Setulipes rhizomorphicola Antonín sp. nov. (Fig. 14)

Pileo 2-13 mm lato, campanulato, membranaceo, striato, glabro, obscure brunneo-griseo vel brunneo, margine griseo-brunneo. Lamellis distantibus, L = 7-8, adnatis, rubro-griseis vel brunneis. Stipite ca 3 × 1 mm, cylindraceo, curvato, insititio, nigro. Basidiosporis 9,0-11,5(-12,5) x 4,0-4,6 µm, ellipsoideis vel sublacrymoideis, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis cheilocystidiorum Marasmii sicci, 15-17 × 6,9-8,5 µm, clavatis, cum projectionibus digitatis. Pileipellis e hyphis cylindraceis vel subinflatis, glabris vel incrustatis et diverticulatis et e cellulis infrequentibus similibus cellulis hymenodermatis Marasmii sicci constructa. Caulocystidiis 45-190 × 6,0-26 µm, lageniformibus vel cylindraceis, crassitunicatis, hyalinis. Hyphis efibulatis vel infrequente fibulatis, in stipite dextrinoideis. Ad rhizomorphas.

HOLOTYPUS: Malawi: Mount Mulanje, 16. XI. 1981 leg. J. Rammeloo 7378 (holotypus in herbario BR 11963-32 asservatur).

Pileus 2-13 mm broad, campanulate, thin, striate, glabrous, dark brown-grey or brown (6D5), paler greyish brown at margin (8C3-8D4). Lamellae moderately distant (L = 7-8), adnate, about 1 mm broad, sometimes slightly intervenose, reddish grey or brown (6D5-8B2). Stipe ± 3 mm long, less than 1 mm wide, cylindrical, curved, black, growing up from rhizomorphs.
Basidiospores 9.0-11.5(-12.5) x 4.0-4.6 µm, E = 2.1-2.9, Q = 2.3-2.6, ellipsoid or sublacrymoid, thin-walled, hyaline, smooth. Basidia 25-31 x 8.5-10.5 µm, 4-spored, clavate. Basidioles 11.5-33 x 3.0-10 µm, cylindrical, clavate, fusoid. Cheilocystidia shaped as broom-cells of the Siccus-type, 15-17 x 6.9-8.5 µm, clavate, thin-walled, with ± digitate, slightly thick-walled projections. Pleurocystidia absent. Pileipellis a cutis of ± cylindrical to subinflated, thin- to slightly thick-walled, smooth or often incrusted, slightly gelatinised, up to 12.0 µm wide hyphae, with digitate, obtuse, simple to coralloid, slightly thick-walled projections; mixed with scattered broom-cells; thick-walled parts and incrustation dark brown in KOH. Stipitipellis a cutis of cylindrical, parallel, slightly thick-walled, incrusted, up to 6.0 µm wide hyphae with brown walls in KOH. Caulocystidia 45-190 x 6.0-26 µm, setoid, lageniform, cylindrical or awl-shaped, obtuse to subacute, thick-walled (up to 3.5 µm), hyaline. Clamp-connections absent or scattered. Chemical reactions: basidiospores and pileus trama non-dextrinoid, stipe hyphae dextrinoid.
Ecology: Saprophytic, on rhizomorphs hanging from shrub and tree branches in gallery forest and montane forest with *Widdringtonia* and *Podocarpus*, sometimes also on twigs.

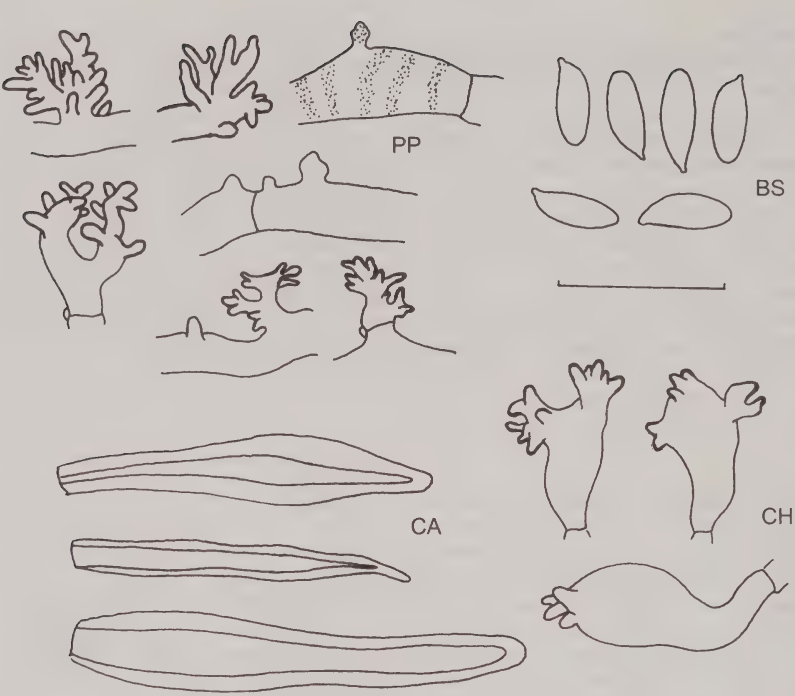

Fig. 14. *Setulipes rhizomorphicola* (holotype).

Distribution: It has been collected in Malawi.
Revised specimens: Malawi: Mount Mulanje, C.C.A.P. station, 16 Nov. 1981 leg. J. Rammeloo 7378 (BR 11963-32, holotype).

Setulipes rhizomorphicola is characterised in having a stipe arising directly from rhizomorphs, rather large basidiospores, cheilocystidia shaped as broom-cells of the Siccus-type or as (almost) smooth cells, thick-walled setoid caulocystidia and only scattered or none clamp-connections.

Among species arising (at least sometimes) directly from rhizomorphs, *Marasmius rigidichorda* Petch has smaller basidiospores (6.5-8.5 x 3-3.5 µm) (Pegler 1986, Petch 1948); *M. tomentellus* Berk. & M.A. Curtis, without clamp-connections, has a smaller, 1-3 mm broad pileus, less numerous lamellae (L = 1-5), slightly broader basidiospores (11-11.5 x 4-5 µm) with a curved basal part and ampullaceous cystidia, and *M. bactrosporus* Singer has a fuscous grey pileus, more frequent lamellae (L = 12-17), narrower basidiospores (10-12 x 2.7-3.7 µm) and possesses pleurocystidia (Singer 1976).

NEW COMBINATIONS

***Setulipes kisangensis* (Singer) Antonín comb. nov.**
BASIONYM: *Marasmius kisangensis* Singer, Bull. Jard. Bot. Brux. 34: 324. 1964.

***Setulipes hakgalensis* (Petch) Antonín comb. nov.**
BASIONYM: *Marasmius hakgalensis* Petch, Trans. Brit. Mycol. Soc. 31: 42. 1948.

NEW NAME

***Marasmius davidii* Antonín nom. nov.**
REPLACED SYNONYM: *Marasmius helvolus* Berk. var. *brunneolus* Berk. & Broome, J. Linn. Soc. Bot. 14: 38. 1873.
= *Marasmius brunneolus* (Berk. & Broome) Pegler, Kew Bull. Add. Ser. 12: 163. 1986.

NON *M. brunneolus* (Beeli) Singer, Bull. Jard. Bot. Brux. 34: 344. 1964.
SYN.: *Marasmius bekolacongoli* var. *brunneolus* Beeli, Bull. Soc. Roy. Bot. Belg. 60: 157. 1928.

Marasmius brunneolus (Berk. & Broome) Pegler belongs to sect. *Sicci*, whereas *M. brunneolus* (Beeli) Singer to sect. *Globulares* (holotype BR 11414-65!), and therefore undoubtedly represent different species. Therefore, I propose the new name *M. davidii* Antonín, for the first one.

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References

Dennis R. W. G. (1970): Fungus flora of Venezuela and adjacent countries. – Kew Bull. Addit. Ser. 3: 1-531.

Desjardin D. E. & Horak E. (1997): Marasmius and Gloiocephala in the South Pacific Region: Papua New Guinea, New Caledonia, and New Zealand taxa. Part 1: Papua New Guinea and New Caledonia taxa, Part 2: New Zealand taxa. – In: Petrini O., Petrini L. E. & Horak E. (eds.), Taxonomic monographs of Agaricales II, Bibl. mycol. 168: 1-152.

Desjardin D. E. & Petersen R. H. (1989a): Studies on Marasmius from Eastern North America. III. Marasmius brevipes and Micromphale sect. Rhizomorphigena. – Mycologia 81: 76-84.

Desjardin D. E. & Petersen R. H. (1989b): Studies on Marasmius from Eastern North America. I. Marasmius straminipes and a new variety. – Mem. New York Bot. Garden 49: 181-186.

Desjardin D. E., Retnowati A. & Horak E. (2000): Agaricales of Indonesia. 2. A preliminary monograph of Marasmius from Java and Bali. – Sydowia 52(2): 92-194.

Pegler D. N. (1983): Agaric flora of the Lesser Antilles. – Kew Bull., Addit. Ser. 9: 1-668.

Pegler D. N. (1986): Agaric flora of Sri Lanka. – Kew Bull., Addit. Ser. 12: 1-519.

Petch T. (1948): A revision of Ceylon Marasmii. – Trans. Brit. Mycol. Soc. 31: 19-44.

Singer R. (1960): Monographs of South American Basidiomycetes, especially those of the East Slope of the Andes and Brazil. 3. Reduced marasmioid genera in South America. - Sydowia, Ann. Mycol., 14: 258-280.

Singer R. (1964): Marasmius congolais recueillis par Mme Goossens-Fontana et d´autres collecteurs belges. - Bull. Jard. Bot. Brux. 34: 317-388.

Singer R. (1976): Marasmiae (Basidiomycetes-Tricholomataceae). – Fl. Neotrop. 17: 1-347.

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PANDORA UROLEUCONII SP. NOV. (ZYGOMYCETES: ENTOMOPHTHORACEAE), A NEW PATHOGEN OF APHIDS

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ABSTRACT

Pandora uroleuconii sp. nov. is described and illustrated. It possesses branched conidiophores, ellipsoid to ovoid monokaryotic and bitunicate primary conidia, pseudocystidia, and large nuclei staining distinctly with aceto-orcein. Rhizoids are absent. The pathogen differs from other species of the genus by absence of rhizoids, different size of primary conidia, growth on standard media and probably high host specialization. *P. uroleuconii* attacked aphid species *Uroleucon aeneum* during May and June in many localities in Slovakia. The species did not grow on standard media and did not exhibit infectivity to five common aphid species, *Acyrthosiphon pisum*, *Diuraphis noxia*, *Metopolophium dirhodum*, *Myzus persicae* and *Rhopalosiphum padi*. The new fungal species is compared and contrasted with similar species of the genus.

Keywords: Entomophthorales, aphidophagous fungi, *Uroleucon aeneum*, Slovakia

During a survey of aphidophagous Entomophthorales in Slovakia, the aphid *Uroleucon aeneum* (Hille Ris Lambers) colonising *Carduus nutans* Linnaeus was found being attacked by fungus with specific taxonomic features allowing us to erect it as a new species. The fungus fits in almost all respects into genus *Pandora* (Humber 1989) by possessing elongate monokaryotic conidia with an outer wall, which may partially separate from an inner one, and by having large nuclei staining readily with aceto-orcein. Rather long tapering pseudocystidia at base 1.5 to twice as thick as conidiophores and branched conidiophores also support the placement in the genus *Pandora*. Lack of monohyphal rhizoids would seem to be the only obstacle in placing the fungus in *Pandora*, however, there is at least one further valid species devoid of rhizoids, *Pandora delphacis* (Hori) Humber, assigned to the genus. Rhizoids are also fungal structures, which might help readily distinguish *Pandora* from *Erynia* or *Furia*.

In the light of our observations the organism is described here as a new species. The description that follows is based on a general appearance of the pathogen as it occurs in naturally infected aphids and on its microanatomy as observed in aceto-orcein (AO).

Pandora uroleuconii Barta & Cagan, sp. nov.

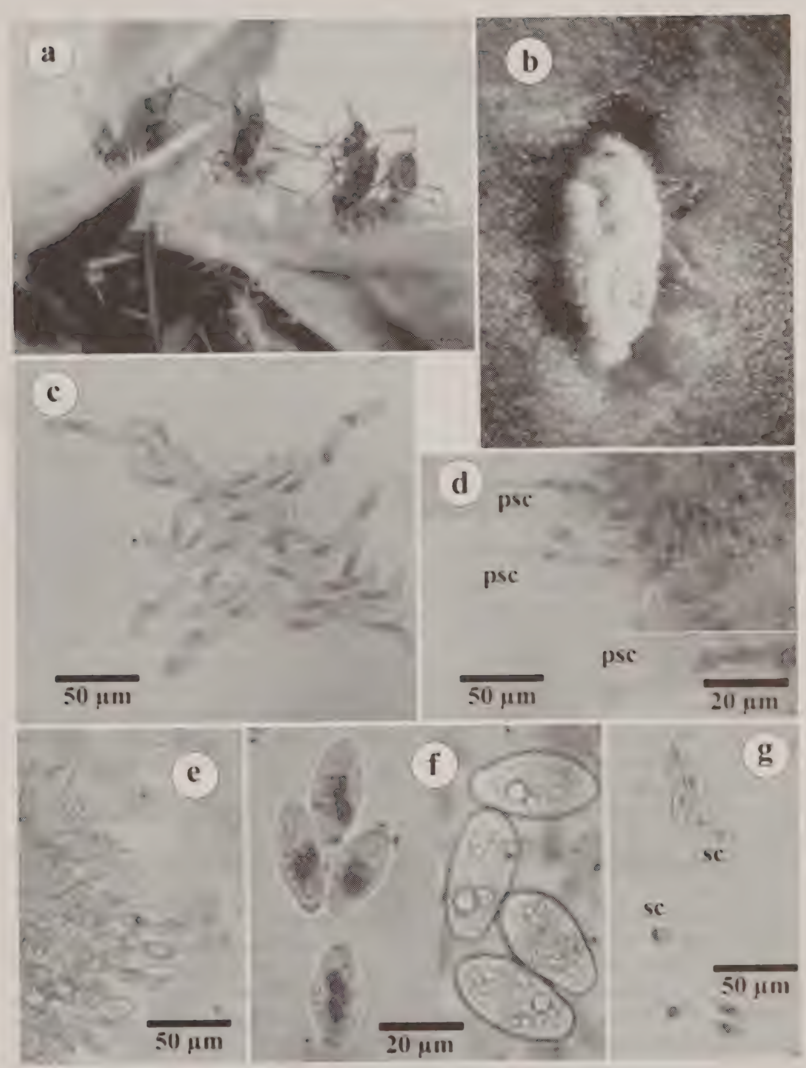
Diagnosis: *Corpora hyphalia elongata, hyphoidea vel irregulariter ramosa, uninucleata vel oligonucleata (1-6 nucleis praedita), 9.28 – 10.08 (7.92 – 12.87) µm* *crassa, 120.6 (66.8 - 200.5) µm longa. Pseudocystidia simplicia, 176.6 (138.6 – 207.9) µm longa, ad basim 15.46 (11.88 – 19.80) µm crassa, in medio longitudinis 9.5 (7.92 – 11.88) µm crassa, deinde leniter attenuata ad 5.99 (5.18 – 6.35) µm in apicibus. Conidiophora ramosa, intertexta in hymenium continuum, 10.18 – 11.33 (9.90 – 12.87) µm crassa, cellulae conidiogenae angustuae in apicibus in diametro 5.84 – 6.39 (4.95 – 7.72) µm. Conidia primaria uninucleata, bitunicata, hyalina, elliptica vel ovoidea, dorso-ventraliter asymmetrica, dimensionibus ex insectis 24.71 – 33.03 (21.78 – 41.58) µm x 11.57 – 17.19 (9.90 – 22.77) µm L/D* proportione: 1.79 – 2.25. Conidia secundaria minora, vel conidia primaria similia (18.14 – 19.21 (15.84 – 27.72) µm x 9.31 – 9.62 (7.92 – 11.88) µm L/D: 1.93 – 2.01) vel fere globosae cum conspicuis papillis (17.27 – 18.45 (11.88 – 27.72) µm x 9.58 – 10.18 (7.92 – 11.88) µm L/D: 1.70 – 1.93). Nuclei in corporibus hyphalibus et conidii magni, 5.46 – 7.09 (3.96 – 8.91) µm in diametro. Sporae perdurantes inobservata. Rhizoidea absunt. Fungus in mediis artificialibus „SEMA“, „EYM“ et „EY“ non crescit. In nymphis et imaginibus Homopterosum (Aphidoidea), Uroleucon aeneum (Hille Ris Lambers) (hospite typico).*

***Holotypus:** Specimen numero Cr 443 in collectione Instituti Botanici (Slovacum Musaeum Nationale) designatum, in Komjatice (Slovacia), die 25 mensis Iunii anno 1999, coll. et leg. M. Barta.*

***Paratypus:** Specimen numero 25/2002 in collectione Instituti Protectionis Plantarum (Slovaca Universitas Agriculturae in Nitria) designatum, in Nitra (Slovacia), die 30 mensis Iunii anno 2002, coll. et leg. M. Barta.*

**Abbreviatione L/D utimur, quae in lingua Anglorum proportionem longitudinis ad crassitudinem significat.*

Mycelium develops inside host in form of mono- to oligokaryotic, simple hyphae-like or irregularly shaped, sometimes ramified hyphal bodies 9.28 – 10.08 (7.92 – 12.87) µm thick (4x25 objects) and 120.6 (66.8 – 200.5) µm long (2x25 objects). Number of nuclei ranges from 1 to 6 per one hyphal body with average of 2 nuclei (4x25 objects). Pseudocystidia present but not prominent, simple and narrowing towards the obtuse apex, 15.46 (11.88 – 19.80) µm thick at base (13 objects), 9.5 (7.92 – 11.88) µm (25 objects) thick in the middle of their length and 5.99 (5.18 – 6.35) µm (25 objects) at the apex, average length 176.6 (138.6 – 207.9) µm (25 objects). Conidiophores branched interweaving to form a continuous hymenium more ore less completely covering pleural and dorsal parts of host's body, conidiogenous cells slightly enlarged in subapical parts and constricted at their apex under forming conidia, with a diameter of 10.18 – 11.33 (9.90 – 12.87) µm (2x25 objects) and 5.84 – 6.39 (4.95 – 7.72) µm (2x25 objects) at their constricted necks. Primary conidia ellipsoid, broadly ellipsoid to ovoid, 24.71 – 33.03 (21.78 – 41.58) µm x 11.57 – 17.19 (9.90 – 22.77) µm L/D: 1.79 – 2.25 (10x25 objects), monokaryotic and bitunicate (with a separable outer wall layer except over the basal papilla); papilla rounded, centred on spore axis or displaced laterally. Secondary conidia formed singly on a short conidiophore arising laterally from a primary conidium and forcibly discharged, more or less similar to primary conidia 18.14 – 19.21 (15.84 – 27.72) µm x 9.31 – 9.62 (7.92 – 11.88) µm L/D: 1.93 – 2.01 (4x25 objects) or broadly ovoid 17.27 – 18.45 (11.88 – 27.72) µm x 9.58 – 10.18 (7.92 – 11.88) µm L/D: 1.70 – 1.93 (4x25 objects). Nuclei easily distinguished in vegetative or reproductive structures, staining readily with aceto-orcein and large with diameter of 5.46 – 7.09 (3.96 – 8.91) µm (8x25 objects) in primary spores. Rhizoids unobserved and probably not formed. Mouthparts and forelegs of cadavers were also carefully examined for rhizoid-like structures, but no monohyphal structures resembling


a
b
c
50 µm
d
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psc
50 µm
20 µm
e
50 µm
f
20 µm
g
sc
sc
50 µm

Figure 1. Morphology of *Pandora uroleuconii* sp. nov.

a) killed aphids adhered to the plant by their proboscises; **b)** cadaver with released spores around it; **c)** hyphal bodies (aceto-orcein "AO"); **d)** pseudocystidia (**psc**) protruding over a conidial layer (AO); **e)** conidiophores with forming primary conidia; **f)** primary conidia (left side – AO); **g)** secondary conidia (**sc**) forming on primary conidia (AO).

rhizoids were observed. No discoid-like holdfast typical to *P. neoaphidis* was noticed. Resting spores unobserved. The fungus does not grow on standard media (Sabourad-dextrose agar enriched with milk and egg yolk – SEMA, egg yolk with milk – EYM, or pure egg yolk – EY).

HOLOTYPE: Specimen No. Cr 443, air-dried cadavers of host aphid (exsiccata), Department of Botany, Slovak National Museum, coll. M. Barta, 25 June 1999, Komjatice, Slovakia

PARATYPE: Specimen No. 25/2002, air-dried cadavers of aphids, Department of Plant Protection, Slovak Agricultural University, coll. M. Barta, 30 June 2002, Nitra, Slovakia

TYPE HOST: *Uroleucon aeneum* (Hille Ris Lambers)

TYPE LOCALITY: Komjatice, Slovakia

ETYMOLOGY: *Uroleucon* – generic name of the type host species.

DISTRIBUTION: The species is known only from the type host in Slovakia. The fungus was observed from 19 localities in the country during late spring and early summer (Table 1), and it is considered a frequent pathogen of the aphid species.

Symptoms of disease: Infected cadavers were easily recognised in aphid colonies by their conspicuous posture on a host plant and by an obvious change of their colour during fungal sporulation. With infection progress the mycosed aphids became gradually extended and turgid but, in general, a shape of aphids' bodies remained still unchanged. Diseased cadavers were greyish-brown in colour with a pink tinge immediately after a death. In a final stage of disease development a conidiogenesis appeared followed by a conidial release under humid conditions. At sporulation the colour of cadavers changed from greyish-brown to silver. Due to a lack of rhizoids, aphids killed by the pathogen were attached to the substrate by their proboscises, as well as, by means of their forelegs. The attachment of the cadavers was rather weak and the aphids were easily dislodged from the leaves when being collected. Under dry conditions the cadavers became quite firm, did not sporulate and remained more or less mummified. However, the mummies transferred to a humid chamber began to sporulate readily. The mycelium inside cadavers preserves its viability up to fortnight after storage in refrigerator and the sporulation started usually about two hours after mummies were put on damp filter paper.

The infected aphids were for the first time observed on *C. nutans* in June 1999. Subsequent investigation of *U. aeneum* colonies in Slovakia revealed that the fungus was regular pathogen of the aphid in the course of late spring and early summer, although epizootic level of mycosis has yet not been observed. Table 1 shows localities in Slovakia where the pathogen was recorded. According to our observations the "non-rhizoidal fungus" (described here as *P. uroleuconii*) was the only pathogen of the aphid colonies in 1999 and 2001 (In 2000 we did not observe the aphid colonies). On the contrary, in 2002 besides this fungal species a pathogen with numerous unbranched monohyphal rhizoids terminating in discoid holdfast was observed within the colonies, as well. The "rhizoidal fungus" was identified as the most frequent aphidophagous pathogen, *Pandora neoaphidis* (Rem. & Henn.) Humber. In this year the abundance of *P. neoaphidis* cadavers even predominated over that of "non-rhizoidal fungus" in many colonies and in some of them only *P. neoaphidis* occurred. Both fungi were easily distinguishable *in situ* by external symptoms of mycoses: by a colouration of cadavers and by a characteristic posture of dead aphids on a host plant associated with presence

Table1. List of localities with *Pandora uroleuconii* records, together with coordinates and altitudes of the localities

Locality	**Date of record**	**Coordinates**[1]	**Altitude**[2]
Komjatice	25.6. 1999	48°09’20” 18°10’00”	130
Kamenica nad Hronom	23.5. 2001	47°49’50” 18°43’30”	117
Ruzovy Dvor	3.6. 2001	48°09’20” 18°07’20”	132
Rastislavice	12.6. 2001	48°08’20” 18°04’30”	124
Muzla	13.6. 2001	47°47’40” 18°36’00”	121
Dubno	5.7. 2001	48°11’20” 20°00’20”	234
Spisske Podhradie	6.7. 2001	49°00’00” 20°45’00”	435
Maly Cetin	30.5. 2002	48°14’20” 18°10’50”	135
Jatov	7.6. 2002	48°07’30” 18°00’30”	116
Velky Cetin	13.6. 2002	48°13’00” 18°11’30”	137
Klastor pod Znievom	17.6. 2002	48°58’30” 18°48’00”	500
Valca	17.6.2002	49°00’00” 18°51’00”	450
Habovka	17.6. 2002	49°16’30” 19°37’00”	730
Oravska Polhora	18.6. 2002	49°31’30” 19°26’00”	890
Cernik	23.6. 2002	48°09’20” 18°13’30”	129
Nitra	30.6. 2002	48°19’00” 18°07’00”	173
Zliechov	1.7. 2002	48°57’10” 18°26’00”	603
Korytnica-kupele	2.7. 2002	48°53’20” 19°17’00”	1075
Kostolany pod Tribecom	11.7. 2002	48°24’50” 18°09’40”	245

[1] North latitude and East longitude; [2] metres above sea level

or absence of rhizoids. As aphids killed by the “non-rhizoidal fungus” (greyish-brown in colour) were weakly attached to plant with proboscises, individuals infected by *P. neoaphidis* (ochre-red in colour) were quite firmly attached to plant surface by rhizoids emerging from the ventral part of abdomen.

Despite those dissimilarities in external symptoms, the “non-rhizoidal fungus” is microscopically very similar to *P. neoaphidis* and other species closely related to *P. neoaphidis*, namely *P. delphacis*. The new species, described here, is however distinguished from the both *Pandora* species by growth on standard media and probably high host specialization. Moreover it differs from *P. neoaphidis* by absence of rhizoids and larger primary conidia (Table 2). Differences in conidial size between those pathogens are probably of low taxonomical value since the intraspecific variations in the conidial size of the species are rather great. We assume one source of the intraspecific variation might be a resporulation of some number of primary conidia deposited on microscopic preparations prepared for measurement, thus a certain amount of smaller secondary conidia might bias the results. Anyway, the species cannot be distinguished clearly by the spore size alone, and other taxonomic characters have to be applied in separating the species. Complete absence of rhizoids and pathobiology, especially host range or degree of fungal specificity, we consider a much more important taxonomic feature of *P. uroleuconii*. Taxonomic significance of presence/absence of rhizoids has been decisively discussed during a development of nomenclature of Entomophthorales. Some taxonomists, for delimiting entomophthoralean genera, put no weight on presence of rhizoids in certain species, as they are not always constant (Remaudière and Keller 1980), or others regarded a presence of rhizoids to be taxonomically significant while

Table 2. Gross taxonomical features of the *Pandora* species

Fungal species	***P. uroleuconii* sp. nov.** [1]	***P. neoaphidis* (Rem. & Henn.) Humber** [2]	***P. delphacis* (Hori) Humber** [3]
Primary spore size (μm) LxD; L/D	24.7-33.0 (21.8-41.6) x 11.6-17.2 (9.9-22.8); 1.8-2.3	21.0-32.0 (15.0-40.0) x 11.0-14.0 (9.0-16.0); 1.7-2.3 (1.4-2.9)	22.9-36.8 x 12.4-20.3
Rhizoids	absent	present	absent
Culture	no growth on SEMA, EYM, EY	growth on SDAEY, EYM, EY [4]	fast growth on SEMA [5]
Host spectrum	*Uroleucon aeneum*	plenty of aphid species from several families	plant- and leaf-hoppers (aphids artificially [5,6])

[1] authors' observations, [2] Remaudière and Hennebert 1980, [3] Hori 1906, [4] Keller 1991, [5] Milner et al. 1983, [6] Shimazu 1977

L – length, D – diameter, SDAEY – Sabourad-dextrose-agar enriched with egg yolk, SEMA - Sabourad-dextrose-agar enriched with egg yolk and milk, EYM – egg yolk with milk, EY – egg yolk

their absence was not considered a reliable criterion at a generic level (King and Humber 1981). Other authorities believe that rhizoids have a value at subgeneric level (Ben-Ze'ev and Kenneth 1981) or have value as a secondary generic character while certain exceptions are accepted, e.g. *P. delphacis* (Humber 1981, 1989). Bałazy (1993) questioned the taxonomic significance of rhizoids for *P. neoaphidis* when he mentioned that rhizoids of the fungus might be sometimes on particular individuals underdeveloped or lacking in very dense aphid colonies. Further the author supposed that the *P. neoaphidis*, in the sense referred in current literature, is a species complex. This is in accordance with opinion of Humber (1983). Certain morphological and physiological variation among *P. neoaphidis* strains was highlighted by Keller (1991), as well. We assume that instability in presence of rhizoids observed by Bałazy (1993) for *P. neoaphidis* could be one of signs of variability inside of the taxon. During our investigation the absence of rhizoids was unquestionably a constant character of *P. uroleuconii* as it was noticed on all cadavers in different localities all over the country during four consecutive years. This character was also occurred on cadavers of *U. aeneum* artificially inoculated by the pathogen in the laboratory. The absence of rhizoids was, moreover, associated with other physiological properties of the taxon what differentiated it from "rhizoidal" *P. neoaphidis*.

Besides morphological features discussed before, *P. uroleuconii* is close to *P. delphacis* by absence of rhizoids. However, both species differ in host specificity and growth in artificial cultures. *P. delphacis* is primarily a pathogen of leaf- and planthoppers in Asian rice paddies (Hori 1906; Holdom et al. 1989; Matsui et al. 1998), although the pathogen artificially infected some aphid species in laboratory (Shimazu 1977; Milner et al. 1983; Xu and Feng 2002). The pathogen exhibited even greater pathogenicity to aphids than *P. neoaphidis* (Xu and Feng 2000), however it has never been observed infecting aphids in nature and what is more the species has never been recorded from Europe. In our experiments all attempts for an artificial transmission of *P. uroleuconii* to five aphid species, *Acyrthosiphon pisum* Harris, *Diuraphis noxia* (Mordvilko), *Metopolophium dirhodum* (Walker), *Myzus persicae* (Sulzer) and *Rhopalosiphum padi* (Linneaus), were unsuccessful (3 x 20 apterous aphids were tested against spores from freshly killed *U. aeneum* with a control of 20 individuals). The pathogen infected only the type host, thus indicating what is probably a very narrow host specialization. *P. delphacis* grows more rapidly *in vitro* than *P. neoaphidis* and even it grows on a wider variety of media (nutritionally simple and complex) (Humber 1981; Milner et al. 1983). *P. uroleuconii* unlike those two species did not grow on artificial media. Any attempts to isolate the species failed. Spores of the pathogen apparently germinated after their deposition on media but a hyphal growth ceased shortly; this observation may support our supposition about pathogen's high specificity. Two strains of *P. neoaphidis* were, however, isolated on SEMA from killed *U. aeneum*, and the strains showed pathogenicity to the five aphid species mentioned above. The inability to gain isolates of *P. uroleuconii* prevented us from testing the biochemical and molecular properties that might provide the clearest separation of those morphologically similar species.

P. uroleuconii has been defined by qualitative description of the external morphology, quantitative measurements of the main taxonomical structures, as well as, by observations on host preferences. Although the taxon shows a morphological resemblance in certain features to some representatives of *Pandora* genus, the results of examination presented here we regard to be substantial enough to justify the erection of the new species.

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LITERATURE CITED

Bałazy, S. 1993. Flora of Poland. Fungi (Mycota), vol. 24: Entomophthorales, Polish Academy of Science, Kraków (W. Szafer Institute of Botany, ed.), pp. 356.

Ben-Ze'ev, I., and R. G. Kenneth. 1981. *Zoophthora orientalis* sp. nov., a fungal pathogen of *Aphis citricola* (Homoptera: Aphididae), and two new combinations of other species of Entomophthoraceae. Phytoparasitica 9: 33-42.

Holdom, D. G., P. S. Taylor, R. J. Mackay-Wood, M. E. Ramos, and R. S. Soper. 1989. Field studies on rice planthoppers (Hom., Delphacidae) and their natural enemies in Indonesia. J. Appl. Ent. 127: 118-129.

Hori, S. 1906. Entomogenous fungi of Japan, 2. Konchu-gaku Zasshi 3: 81-83.

Humber, R. A. 1981. An alternative view of certain taxonomic criteria used in the Entomophthorales (Zygomycetes). Mycotaxon 13 (1): 191-240.

Humber, R. A. 1983. Species complexes in the Entomophthorales: New problems for old species. SIP XVI annual meeting, Cornell University, Ithaca New York, August 7-11: 44.

Humber, R. A. 1989. Synopsis of a revised classification for the Entomophthorales (Zygomycotina). Mycotaxon 34 (2): 441-460.

Keller, S. 1991. Arthropod-pathogenic Entomophthorales of Switzerland. II. *Erynia*, *Eryniopsis*, *Neozygites*, *Zoophthora* and *Tarichium*. Sydowia 43: 39-122.

King, D. S., and R. A. Humber. 1981. Identification: Entomophthorales. In: Microbial control of pest and plant diseases (H. D. Burges, ed.), p. 107-127. Academic Press, New York.

Matsui, T., H. Sato, and M. Shimazu. 1998. Isolation of an entomogenous fungus, *Erynia delphacis* (Entomophthorales: Entomophthoraceae), from migratory planthoppers collected over the Pacific Ocean. Appl. Entomol. Zool. 33 (4): 545-549.

Milner, R. J., R. J. Mahon, and W. V. Brown. 1983. A taxonomic study of the *Erynia neoaphidis* Remaudière & Hennebert (Zygomycetes: Entomophthoraceae) group of insect pathogenic fungi, together with a description of the new species *Erynia kondoiensis*. Aust. J. Bot. 31: 173-188.

Remaudière, G., and G. L. Hennebert. 1980. Rèvision systèmatique de *Entomophthora aphidis* Hoffm. in Fres. Description de deux nouveaux pathogènes d´aphides. Mycotaxon 11 (1): 269-321.

Shimazu, M. 1977. Infectivity of *Entomophthora delphacis* (Entomophthorales: Entomophthoraceae) to the cotton aphid, *Aphis gossypii* (Hemiptera: Aphididae). Appl. Entomol. Zool. 12 (2): 200-201.

Xu, J.-H., and M. G. Feng. 2000. The time-dose mortality modelling and virulence indices for two entomophthoralean species, *Pandora delphacis* and *Pandora neoaphidis*, against the green peach aphid, *Myzus persicae* Sulzer. Biological Control 17: 29-34.

Xu, J.-H., and M. G. Feng. 2002. *Pandora delphacis* (Entomophthorales: Entomophthoraceae) infection affects the fecundity and population dynamics of *Myzus persicae* Sulzer (Homoptera: Aphididae) at varying regimes of temperature and relative humidity in the laboratory. Biological Control 25: 85-91.

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THREE NEW ASCOMYCETES FROM A TROPICAL AUSTRALIAN RAINFOREST

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Abstract

Anthostomella reniformis sp. nov. (Xylariaceae), *Gnomonia elaeocarpa* sp. nov. and *Gnomonia queenslandica* sp. nov. (Gnomoniaceae) are described and illustrated from decaying leaves of *Ficus pleurocarpa* and *Elaeocarpus angustifolius,* which were collected in a tropical rainforest of North Queensland, Australia.

Key words: *Anthostomella, Gnomonia, Nipicola*

Introduction

A study to estimate microfungal diversity in decaying leaves of four rainforest tree species in tropical rainforests in North Queensland, Australia (Paulus *et al.*, 2003a; 2003b), resulted in the discovery of three new ascomycete species, which are described and illustrated in this paper. *Anthostomella reniformis* (Xylariaceae) and the two species of *Gnomonia* (Gnomoniaceae) are compared with similar species in their respective genera (Barr, 1978; Monod, 1983; Barr, 1991; Lu and Hyde, 2000; IndexFungorum, 2003).

The genus *Anthostomella* Sacc. was established with the introduction of *Anthostomella limitatus* Sacc. (Saccardo, 1875). With over 300 species, *Anthostomella* is a species-rich genus, which was recently reviewed in a world monograph by Lu and Hyde (2000). Its members are mainly saprobes occurring on stems and leaves of a wide range of plant taxa although some species may be weakly parasitic and probably host-specific (Lu and Hyde, 2000; Promputtha *et al.*, 2002). The genus is widely distributed in tropical, subtropical and temperate regions. A number of anamorphs such as *Geniculosporium, Nodulisporium, Virgariella* and possibly *Zygosporium* have been associated with *Anthostomella* (Lu and Hyde, 2000).

Cesati and de Notaris (1863) introduced *Gnomonia* with a number of species but did not assign a type species. Subsequently, Höhnel (1917) selected the lectotype

G. vulgaris, now accepted under its earlier epithet *G. gnomon* (Barr, 1978; Monod, 1983). *Gnomonia* is a species-rich genus with 269 records in IndexFungorum (2003). Barr (1978) treated 35 species from North America and provided a revised key to 39 North American species in 1991. In his monograph of the Gnomoniaceae, which was mainly focussed on European species but also included some species from Asia, North America and Oceania, Monod (1983) accepted 94 species in *Gnomonia.* Since 1983, a further six species have been described in *Gnomonia* (IndexFungorum, 2003). Members of this genus are usually saprobes although some parasitic species are also included (Barr, 1978). Fruiting bodies are found on leaves and petioles of trees and shrubs and on leaves, peduncles or stalks of herbaceous plants (Barr, 1978; Monod, 1983).

Methods

The two study sites comprise upland rainforest in the vicinity of Bellenden Ker National Park, Queensland, Australia, at an altitude of approximately 650 and 700m. The rainforest of both sites has been classified as complex mesophyll rainforest (Type 1b rainforest; Tracey, 1982) and has a high diversity among tree species. Decaying leaves were collected under six individual trees of *Ficus pleurocarpa* F. Muell. and *Elaeocarpus angustifolius* Blume.

Ascomata of the new species were removed directly from decaying leaves following incubation in humid chambers, which contained tissue paper moistened with sterile distilled water. Some slides were stained with Melzer's reagent to test whether the apical apparatus of asci showed any amyloid reaction. The range of measurements is derived from examining a minimum of 25 ascospores, 20 asci, 10 ascomata per specimen (except for *Anthostomella reniformis* for which three available ascomata were examined) mounted in sterile distilled water. Slides were rendered semipermanent by the addition of 90 % lactic acid. Dried fungal material was deposited at the Queensland Plant Pathology Herbarium (BRIP), Department of Primary Industries.

Taxonomy

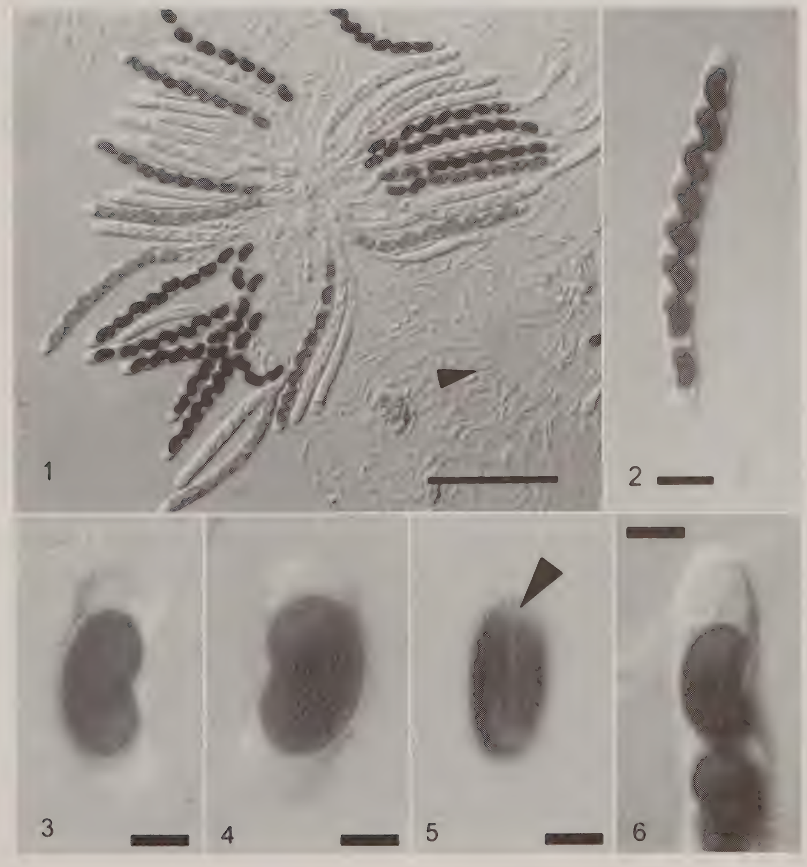
Anthostomella reniformis **Paulus, P. Gadek & K.D. Hyde** ***sp.nov.***

(Figs. 1–6)

Etymology: 'reniformis' refers to the kidney-shaped ascospores.

Ascomata solitaria, infrequentia, subglobosa, nigra, immersa, 220–300 × 150–200 μm, clypeus inobservatum. *Asci* cylindrici, unitunicati, uniseriati 8-spori, (92.5–)105–120 × (7.5–)9–12 μm, annuli amyloide, (3–)4–6 × 4–6 μm. *Ascosporae* reniformes, atro-brunneae, aseptatae, 10–14 × 5–9 μm, appendices gelatinosae, polares, 6.4–8.5 μm latae et 4.2–6 μm longae. *Anamorphosis* ignota. *Holotypus* Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, B. Paulus and I. Steer, 13 June 2002, BP F556 (BRIP 29312), in foliis dejectis *Ficus pleurocarpa.*

Ascomata solitary, infrequent, black, subglobose in vertical section, immersed and appearing as raised dome-shaped areas which are often surrounded by reddish host tissue, central and circular ostiole apparent, at maturity host epidermis may lift to form a lid-like structure, 220–300 × 150–200 μm, peridium composed of dark brown, thick-walled, irregular cells, clypeus not seen. *Paraphyses* embedded in gelatinous



Figs. 1–6. *Anthostomella reniformis*: 1, 2, asci, paraphyses (arrowed); 3, 4, ascospores with appendages; 5, ascospore with germ slit (arrowed); 6, ascal apex. Scale bars: 1 = 50 µm; 2–6 = 5 µm.

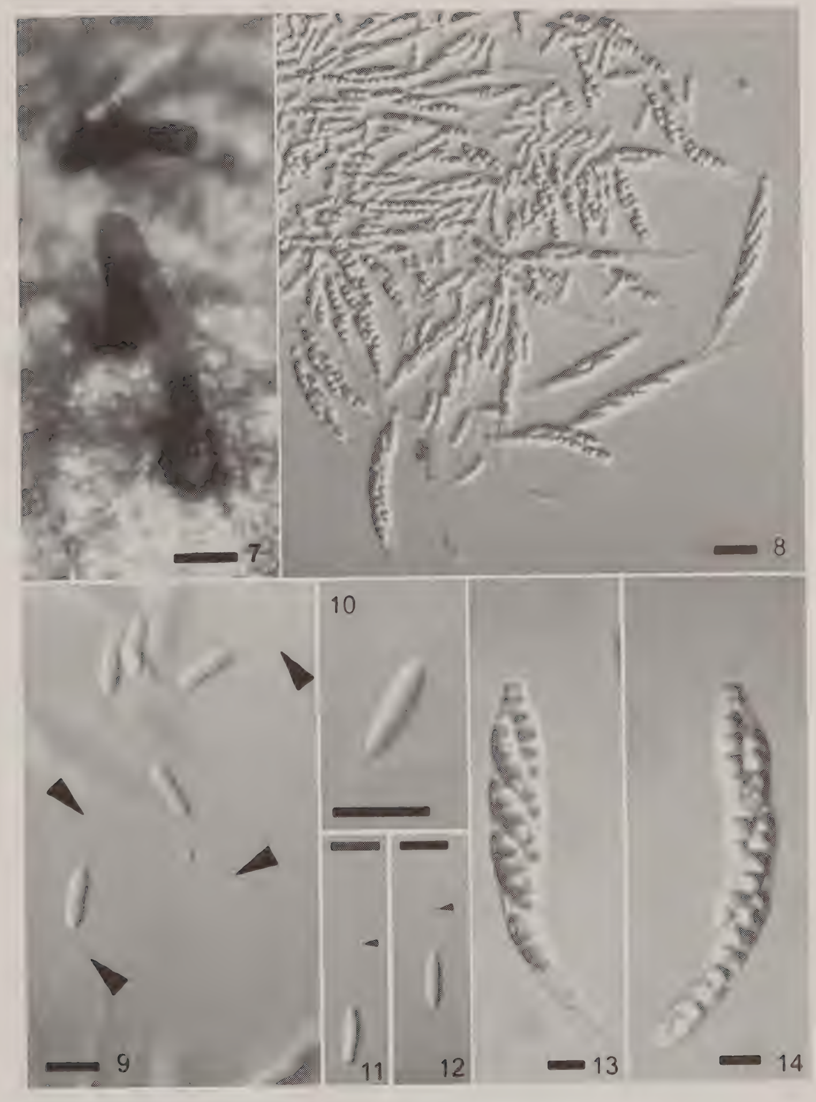
matrix, hyaline, flexuous, apex obtuse, 2–2.5 µm wide. *Asci* cylindrical, unitunicate, 8-spored, uniseriate, (92.5–)105–120 µm × (7.5–)9–12 µm with a J+, subapical annulus, (3–)4–6 × 4–6 µm, apex rounded, pedicel cylindrical with blunt base, approximately 30 µm long. *Ascospores* reniform in lateral view, dark brown, aseptate, 10–14 × 5–9 µm with one gelatinous broad, rounded appendage on each end, 6.4–8.5 µm wide and 4.2–6 µm long, germ slit straight and nearly same length as ascospores, clearly visible in dorsal view and in that orientation, the ascospore shape is ellipsoid. *Anamorph* not observed.

Specimens examined: Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, B. Paulus and I. Steer, 13 June 2002, BP F556 (holotype, BRIP 29312), on decaying leaves of *Ficus pleurocarpa*. Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, B. Paulus and C. Pearce, 27 November 2001, BP F424 (BRIP 29325), on decaying leaves of *Ficus pleurocarpa.*

Notes

For the placement of our specimens, we considered two ascomycete genera, *Anthostomella* and *Nipicola* K.D. Hyde. *Anthostomella* is characterised by ascomata, which have a central ostiole and are typically immersed under a clypeus although the latter may be absent in some species. Its asci are mostly cylindrical, (4-)8-spored and usually short pedicillate. It is also characterised by an amyloid (sometimes inamyloid), subapical apparatus, filamentous paraphyses usually embedded in a gelatinous matrix, darkly pigmented ascospores with or without dwarf cells and germ slits. Initially *Nipicola* included only one species, *Nipicola carbospora* K.D. Hyde, which is characterised by ascomata immersed beneath a reduced clypeus, J- apical pore and black, lunate ascospores with a layered mucilaginous sheath. This generic concept of *Nipicola* was broadened by the inclusion of two further species (Hyde, 1996; Hyde and Taylor, 1996). Both *Anthostomella* and *Nipicola* now contain species with J- or J+ subapical rings, germ slits present or absent, clypeus developed or reduced, dark inequilateral ascospores and mucilaginous ascospore sheaths. However, *Nipicola* seems to differ from *Anthostomella* in the layered nature of the ascospore sheath (Whitton, 1999).

Our specimens resemble *Nipicola* in the darkly pigmented, lunate or reniform ascospores and the apparent absence of a clypeus. The latter character has been reported to vary, even within different samples of the same species (Lu and Hyde, 2000). As only three ascomata were available, it will be necessary to re-examine this character when more specimens are located. Our species differs from *Nipicola* in having simple rather than layered mucilaginous appendages. Within *Anthostomella,* many species have inequilateral ascospores but no species with reniform ascospores has yet been included in this genus (Lu and Hyde, 2000). Generic placement of our species, therefore, remains problematic. In the absence of supporting molecular or ultrastructural data, we have referred it to *Anthostomella* pending further exploration of the generic delimitation between the two genera.



Figs. 7–14. *Gnomonia elaeocarpa:* 7, ascomata; 8, mass of free asci; 9, ascospores with filiform appendages (arrowed); 10, young ascospore with gelatinous appendages; 11, 12, ascospores with filiform appendages (arrowed); 13, 14, asci. Scale bars: 7 = 100 µm; 8 = 15 µm; 9–12 = 10 µm; 13, 14 = 5 µm.

Gnomonia elaeocarpa **Paulus, M.E. Barr & K.D. Hyde** ***sp.nov.***

(Fig.7–14)

Etymology: 'elaeocarpa' refers to the tree species *Elaeocarpus angustifolius* from which the fungus was recorded.

Ascomata numerosa, hypophylla, solitaria, atro-brunnea, e basi globosa vel subglobosa, 250–300 × 200–250 µm, collo medio, brevis, ad apicem pallide brunneo, 100–150 µm longo × 50–90 µm lato, peridio membranaceo cellulis angularibus. *Asci* unitunicati, angusti fusiformes, 8-spori in fasciculo, apice annulo refractivo distincto et J-, ad maturitatem in cavitate ascomatis liberi, 50–80 × 5–9 µm. *Ascosporae* ellipsoid, ad basi et apicem obtusae, medio 1-septatae, ad septum leviter constrictae, hyalinae, 10–15 × 3–4.5 µm, ad maturitatem appendices filiformes, flexuosae, nonramosae, polares, 20–40 µm longae. *Anamorphosis* ignota. *Holotypus* Australia, Queensland, Atherton Tablelands, Millaa Millaa, Brooke's Road, in foliis dejectis *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 13 June 2002, BP F640 (BRIP 29326).

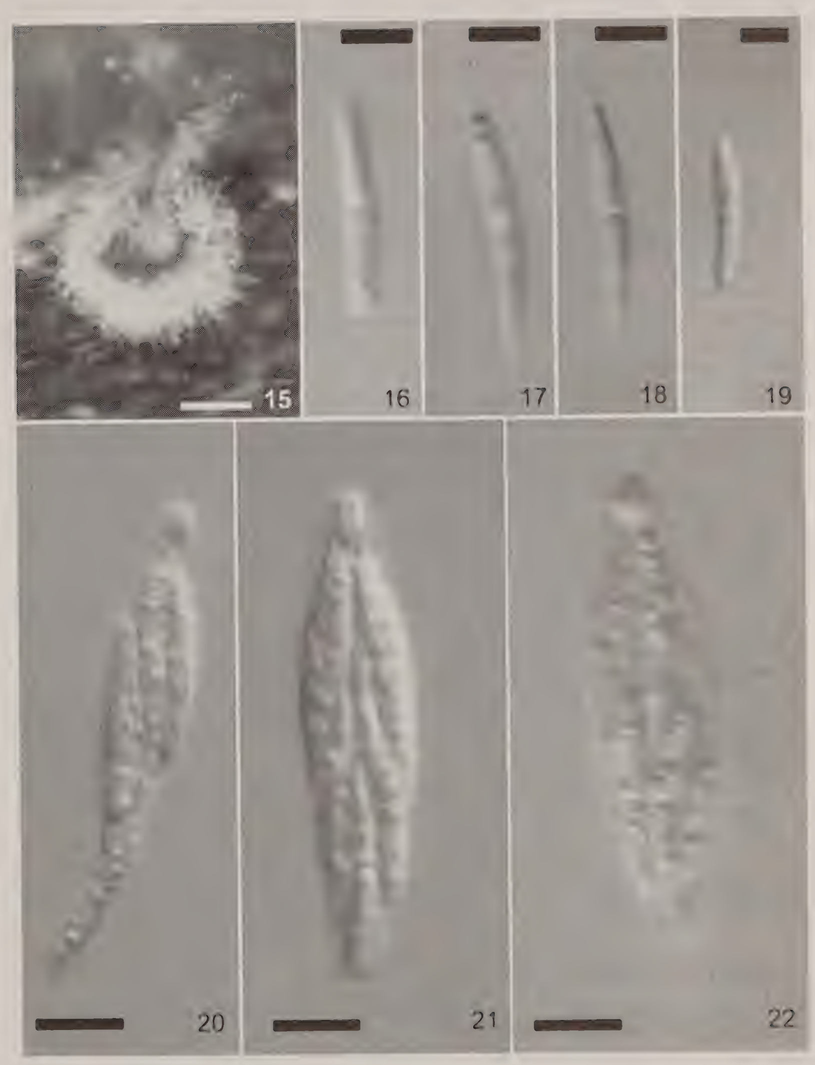
Ascomata numerous, hypophyllous on leaf lamina, single, dark brown, globose to subglobose, semisubmerged, peridium composed of dark brown *textura epidermoidea,* 250–300 × 200–250 µm. Central beak protruding from substratum, 100–150 µm long and 50–90 µm wide, composed of brown *textura porrecta,* paling towards the apex, ostiolar canal lined with periphyses. At maturity an initially white mass of asci is extruded from the ostiolar pore, becoming brown on drying or with age. *Asci* unitunicate, narrowly fusiform, 8-spored, with a J- refractive, complex subapical annulus, 2.5–4 × 2–3 µm, base deliquescing at maturity and asci freed into the centrum, 50–80 µm × 5–9 µm. *Ascospores* ellipsoid with rounded ends, hyaline, guttulate or eguttulate, uniseptate, usually constricted at the median septum, 10–15 µm × 3–4.5 µm with apparently gelatinous broad appendages at each pole when young, which unfold at maturity to become filiform, flexuous and nonbranching, 20–40 µm long; visible in water mount and disappearing in lactic acid. *Anamorph* not observed.

Specimens examined: Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, on decaying leaves of *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 13 June 2002, BP F640 (holotype, BRIP 29327), Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, on decaying leaves of *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 28 May 2002, BP 609 (BRIP 29187).

Notes

Gnomonia elaeocarpa fits into *Gnomonia* section *Latispora* Barr, which is characterised by ellipsoid ascospores with tapering to rounded ends, a median septum and setose appendages when fully formed. Ascospores usually overlap obliquely in the ascus and the ascomata have a narrow beak (Barr, 1978). Within this section, our specimens resemble *G. ribicola* Barr in ascospore shape. However, asci, ascospores and ascospore appendages in our specimens are longer while the beak is much shorter. None of the species described by Monod (1983) resembles *Gnomonia elaeocarpa.*

Barr (1991) noted that members of *Gnomonia* are usually quite host-specific. Our observations are congruent with Barr's statement (1991) as this fungus was not identified in leaf litter of other tree species in close proximity to the *Elaeocarpus angustifolius* trees studied while being present on approximately 86 % of decaying leaves of *Elaeocarpus angustifolius* on six individual trees at two sites. Assuming a high degree of host-specificity, the type of substratum is a valuable character in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Figs. 15–22. *Gnomonia queenslandica*: 15, ascoma; 16–18, ascospores with gelatinous appendages; 19, ascospore with filiform appendages; 20–22, asci. Scale bars: 15 = 250 µm; 14, 16–22 = 5 µm.

species delimitation (Barr, 1978). To our knowledge, no other species of *Gnomonia* has been previously described from *Elaeocarpus* (Barr, 1978; Monod, 1983; Barr, 1991; CBS Fungi Database, Centraalbureau voor Schimmelcultures, 2003; PDD Collection Database, Landcare Research, 2003; USDA, Systematic Botany and Mycology Laboratory Databases, 2003).

Gnomonia queenslandica* Paulus, M.E. Barr & K.D. Hyde *sp. nov.

(Fig. 15–22)

Etymology: 'queenslandica' referring to the state of Queensland, Australia, where the fungus was first recorded.

Ascomata dispersa vel aggregata, plerumque in petiolo vel nervis principalibus, atro-brunnea, e basi globosa, 300–500 µm, rostrum medio, longo angusto rigido cylindrico, brunneo, ad apicem pallide brunneo, 320–550(–1400) µm longo, ad basi 45–55 µm lato, ad apicem 22–27 µm lato, collum flavum rostrum cingens ex substrato. *Asci* numerosi, ellipsoide, unitunicati, (4–) 8 spori, 20–34 × 4.5–7(–8) µm, apice annulo refractivo distincto et J-, 2.5–4.5 × 2–3 µm, ad maturitatem in cavitate ascomatis liberi. *Ascosporae* fusiformes, hyalinae, medio 1-septatae, (9–) 13–16 × 1–2 µm, ad maturitatem appendices filiformes, flexuosae, nonramosae, polares, <20 µm longae. *Anamorphosis* ignota. *Holotypus* Australia, Queensland, Atherton Tablelands, Millaa Millaa, Brooke's Road, in foliis dejectis *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 13 June 2002, BP F641 (BRIP 29326).

Ascomata single or aggregated, predominantly found on petioles, on the adaxial surface of midribs and on domatia on the adaxial leaf surface, dark brown, base globose, semisubmerged to superficial, 300–500 µm in diameter, upper part of ascoma and long, narrow, central beak protruding from substratum; beak 320–550(–1400) µm long, 45–55 µm at base tapering to 22–27 µm at apex, yellow to orange, powdery collar at the base of beak, ostiolar canal lined with periphyses, external layer of beak composed of *textura porrecta;* peridium composed of dark brown to black *textura epidermoidea.* At maturity an initially white mass of asci is extruded from the ostiolar pore, becoming brown on drying or with age. *Asci* numerous, elliptical or broadly elliptical, often narrowed toward apex, unitunicate, (4-)8-spored, 20–34 × 4.5–7(–8) µm, with a distinct J- refractive, complex subapical annulus, 2.5–4.5 × 2–3 µm, base deliquescing at maturity and asci freed into the centrum. *Ascospores* narrowly fusiform, hyaline, guttulate or eguttulate, uniseptate, (9–)13–16 × 1–2 µm, with filiform appendage at either pole, initially gelatinous, 3–8 µm long, at maturity forming a filiform, unbranched appendage up to 20 µm long. *Anamorph* not observed.

Specimens examined: Australia, Queensland, Atherton Tablelands, Millaa Millaa, Brooke's Road, on decaying leaves of *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 13 June 2002, BP F641 (holotype, BRIP 29326). Australia, Queensland, Atherton Tablelands, Topaz, Old Boonjie Road, on decaying leaves of *Elaeocarpus angustifolius,* B. Paulus and I.G. Steer, 28 May 2002, BP 608 (BRIP 29187).

Notes

Gnomonia queenslandica can be accommodated in *Gnomonia* section *Seta* Barr. This section is characterised by narrow, fusoid ascospores tapering to more or less pointed ends with a median septum and setose appendages. Members of this section also have a narrow beak (Barr, 1978). Within this section, *G. queenslandica* is similar to *G. petiolarum* (Schwein. ex Fries) Cooke in ascospore shape and size, in the presence of a collar and in the preferred substrata, i.e. petioles and major veins (Barr, 1978). It differs in its shorter ascospores with much longer appendages, its larger ascomata, and in having a yellow or orange rather than a white collar.

Two species listed by Monod (1983) resemble *G. queenslandica* in some characters. *Gnomonia alni-viridis* Podlahova & Svrček is similar in ascus and ascospore shape and size but differs in the morphology of the apical apparatus, in the length of ascospore appendages, in the absence of a collar and in the type of preferred leaf tissues. *Gnomonia rubi-idaei* Monod resembles our specimens in ascus and ascospore shape with long filiform appendages and as it commonly occurs on petiole and vein tissues of its host. However, it differs in ascospore length, in the morphology of the apical apparatus and in the absence of a yellow or orange collar.

Gnomonia queenslandica occurred on approximately 72 % of leaves examined and like *G. elaeocarpa* was not observed on decaying leaves of other tree species in the vicinity of the *Elaeocarpus* trees studied. Ascomata of *G. queenslandica* were invariably restricted to petioles, the abaxial surface of midribs and domatia on the adaxial leaf surface. Recurrence on certain tissue types or positions on leaves, e.g. petioles, epiphyllous versus hypophyllous, or hosts has been previously reported from other *Gnomonia* species and has been used as taxonomic character in species delimitation (Barr, 1978; Monod, 1983). As noted above, no other species of *Gnomonia* appears to have been described from *Elaeocarpus* (Barr, 1978; Monod, 1983; Barr, 1991; CBS Fungi Database, Centraalbureau voor Schimmelcultures, 2003; PDD Collection Database, Landcare Research, 2003; USDA, Systematic Botany and Mycology Laboratory Databases, 2003).

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Literature Cited

Barr, M.E. (1978). *The Diaporthales of North America.* J. Cramer, Lehre, Germany.

Barr, M.E. (1991). Revisions and additions to the Diaporthales. Mycotaxon 41: 287–305.

Cesati, V. and de Notaris, G. (1863). Schema di classificazione degli Sferiacei Italici aschigeri. Comment. Soc. Crittog. Ital. 1: 177–240.

CBS Fungi Database (2003). *http://www.cbs.knaw.nl/scripts/CBSFungi.dll/.* Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands.

PDD Collection Database (2003). *http://nzfungi.landcareresearch.co.nz/html/mycology.* Landcare Research, Auckland, New Zealand.

Systematic Botany and Mycology Laboratory Databases (2003). *http://nt.ars-grin.gov/fungaldatabases.* United States Department of Agriculture, Beltsville, Maryland, USA.

Höhnel, F.v. (1917). System der Diaportheen. Ber. Deut. Bot. Ges. 35: 631–638.

Hyde, K.D. (1996). Fungi from palms: XXVII. The genus *Anthostomella,* with ten new species. Nov. Hedw. 62: 273–340.

Hyde, K.D. and Taylor, J.E. (1996). Fungi from palms. XXXI. The genus *Nipicola* (Ascomycetes, Xylariaceae), with one new species. Nov. Hedw. 63: 417–424.

IndexFungorum. (2003). *http://www.indexfungorum.org/Names.asp.* CAB International, Egham, Surrey, U.K.

Lu, B.-S. and Hyde, K.D. (2000). *A World Monograph of Anthostomella.* Fungal Diversity Press, Hong Kong, SAR, China.

Monod, M. (1983). Monographie taxonomique des Gnomoniaceae (Ascomycetes de l'ordre des Diaporthales). I. Beih. Syd. 9: 1–302.

Paulus, B., Gadek, P. and Hyde, K.D. (2003a). Estimation of microfungal diversity in tropical rain forest leaf litter using particle filtration: the effects of leaf storage and surface treatment. Myc. Res. in press.

Paulus, B., Gadek, P. and Hyde, K.D. (2003b). Two new species of *Dactylaria* (anamorphic fungi) and an update of species in *Dactylaria sensu lato.* Fung. Div. in press.

Promputtha, L., Lumyong, S., Lumyong, P., McKenzie, E.H.C. and Hyde, K.D. (2002). Fungal succession on senescent leaves of *Manglietia garrettii* in Doi Suthep-Pui National Park, northern Thailand. Fung. Div.10: 89–100.

Saccardo, P.A. (1875). Conspectus generum pyrenomycetum italicosum additus speciabus fungorum venetorum novis vel criticus, systemate carpologico disopositorum. Atti Soc. Venet.-Trent. Sci. Nat. Padova 4: 77–100.

Tracey, J.G. (1982). *The Vegetation of the Humid Tropical Region of North Queensland.* CSIRO, Melbourne, Australia.

Whitton, S. (1999). *Microfungi on the Pandanaceae.* PhD, University of Hong Kong, Hong Kong.

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NEW OR RARELY REPORTED LICHENICOLOUS FUNGI AND LICHENS FROM THE CANADIAN ARCTIC

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ABSTRACT: Sixteen lichenicolous fungi and eight rarely collected lichens are reported from the Canadian Arctic. Five species of lichenicolous fungi (*Dacampia rufescentis, Lasiosphaeriopsis stereocaulicola, Pronectria solorinae, Stigmidium croceae* and *Taeniolella christiansenii*) are herein reported as new to North America (excluding Greenland), another four lichenicolous fungi (*Dactylospora deminuta, Stigmidium frigidum,* and *Thamnogalla crombiei*) and one lichen (*Psora luridella*) are new to Canada. *Flavocetraria nivalis* is a new host for *Phaeosporobolus usneae.*

Key words: North America, Nunavut, tundra, vegetation type

INTRODUCTION

This paper focuses on lichenicolous fungi of the Canadian Arctic, a region still providing a gap in our knowledge of this group of organisms. The neighboring areas are much better known in this respect. For example, there are quite a number of reports of lichenicolous fungi from extra-Arctic Canada, mainly from British Columbia (Noble *et al.,* 1987; Goward and Thor, 1992; Goffinet, 1994; Goward *et al.,* 1994; Brodo, 1995; Aptroot, 1996; Goward *et al.,* 1996; Alstrup and Cole, 1998; Scholz, 1998; Cole and Hawksworth, 2001), as well as from Alaska (Zhurbenko *et al.,* 1995; Geiser *et al.,* 1998), Russian Arctic (Zhurbenko and Santesson, 1996; Karatygin *et al.,* 1999), and Greenland (Alstrup and Hawksworth, 1990; Alstrup *et al.,* 2000). The most recent comprehensive contributions to the knowledge of lichenicolous fungi of North America are papers of Hafellner *et al.* (2003) and Diederich (2003).

MATERIAL AND METHODS

The species dealt with in this paper stem from about 500 lichen collections of the second author made during his phytosociological studies in the Canadian Arctic in 1992 and 1999. The 1992 collections are from Ellesmere Island (Sverdrup Pass) and Cornwallis Island (Resolute), while the 1999 collections stem from localities visited by the CANTRAN-Expedition (Gonzales *et al.,* 2000) at Ellesmere, Axel Heiberg and Cornwallis Islands.

All specimens were identified by the first author by means of standard microscopic techniques. External morphology was studied with a dissecting LOMO Stereomicroscope MBS-1. Anatomical characters were studied using LOMO MBR-3 light microscope. The nomenclature follows Esslinger (1997). Voucher specimens are preserved in herbarium LE. Additional information on some Canadian specimens of the treated taxa preserved in CANL was provided by Dr. I. M. Brodo.

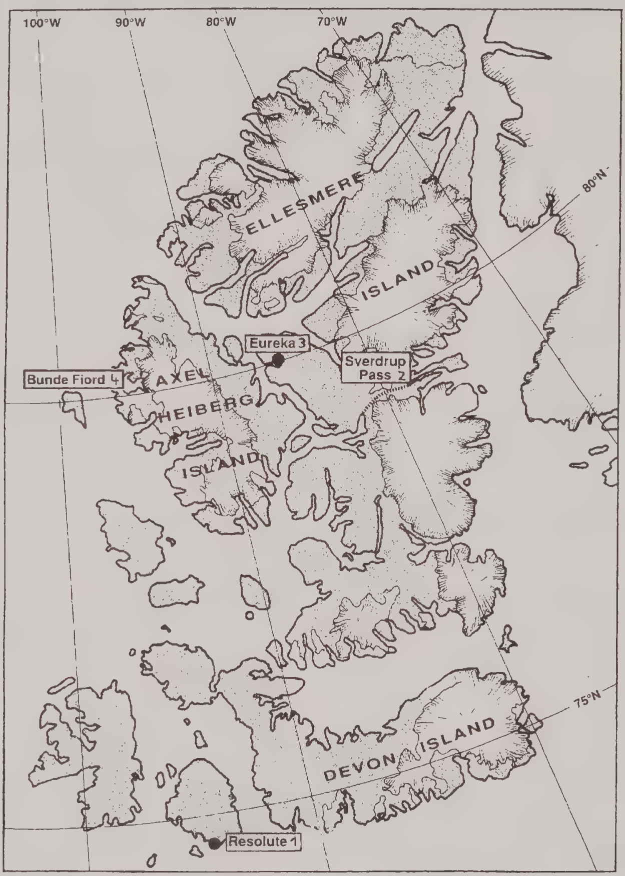
100°W
90°W
80°W
70°W
80°N
75°N
ELLESMERE
ISLAND
AXEL
HEIBERG
ISLAND
DEVON
ISLAND
Eureka 3
Sverdrup Pass 2
Bunde Fiord 4
Resolute 1

Fig. 1. Map of the collection localities. For explanation see text.

STUDY AREA AND COLLECTION LOCALITIES

The study area is located in Nunavut, a new territory of Canada formerly part of the Northwest Territories (Fig. 1). All collecting localities are within the Arctic. Their phytogeographical position within the Arctic territory is indicated using the terminology of Daniëls *et al.* (2000). Nomenclature of vegetation types follows Daniëls and Wilhelm (2002).

Locality 1a: Cornwallis Island, Resolute Bay, near the air base, 74°41'N, 94°55'W, northern arctic dwarf shrub zone, with mainly semi-polar desert and polar desert vegetation on gravelly substrates of limestone, dolomite and calcareous shale. The terrain configuration is generally low and gently undulating (cf. Kojima, 1991).

Locality 1b: Cornwallis Island, Resolute Bay, north of Signal Hill, 74°44'N, 94°52'W, northern arctic dwarf shrub zone. See further above.

Locality 2: Ellesmere Island, Sverdrup Pass, 79°08'N, 81°27'W, middle arctic dwarf shrub zone, with lush tundra vegetation in the valley bottom (ca. 300m alt.) and semi-polar desert and polar desert vegetation on the borderings slopes and higher plateaus. On the south side of the pass granitic outcrops and moraines occur, whereas dolomitic scree slopes, cliffs and plateaus are on the north side (cf. Bergeron and Svoboda 1989; Levesque 1997).

Locality 3a: Ellesmere Island, Eureka, north of the airstrip, 80°00'N, 85°46–48'W, middle arctic dwarf shrub zone, with tundra and semi-polar desert vegetation on old circumneutral marine sediments.

Locality 3b: Ellesmere Island, Eureka, Black Top Ridge, 80°04'N, 85°29'W, polar desert vegetation on gravelly, stony circumneutral substrate.

Locality 3c: Ellesmere Island, Eureka, East Wind Lake, 80°06'N, 85°34'W, middle arctic dwarf shrub zone, with extensive tundra wetlands surrounded by mesic tundra and semi-polar desert vegetation on circumneutral soil.

Locality 4: Axel Heiberg Island, Bunde Fiord, 80°30'N, 94°35'W, northern arctic dwarf shrub zone, with semi-polar desert vegetation on dry sites and tundra vegetation on moist and wet sites on circumneutral soil.

RESULTS

As no studies of lichenicolous fungi have been made in the Canadian Arctic previously, all of the 16 species reported here from the area are new records. Of these five are new to North America, according to Esslinger (1997; excluding Greenland) and available literature, and another three are new to Canada. In addition, seven lichen species are listed, that have been rarely reported from the area, and one lichen species, that is apparently new to Canada.

List of Taxa

Lichens are marked with "§", species denoted by "**" are new to North America (excluding Greenland), and those marked with "*" are new to Canada. All collections were made by F. J. A. Daniëls.

§***Buellia pulverulenta*** (Anzi) Jatta

Locality 2: alt. 350 m, in dry *Papaveretum radicatae* vegetation on exposed coarse stony granitic substrate, on *Physconia muscigena* (Ach.) Poelt (thallus), 24 July 1992; *ibid.*, in moist *Carici-Dryadetum integrifoliae* vegetation on permafrost in old mixed granitic moraine deposits, on *Physconia muscigena* (thallus), 26 July 1992. **Locality 4:** alt. 100 m, near bird stone, on *Physconia muscigena* (thallus), 1 Aug. 1999. – Previous records from the Canadian Arctic are shown in Thomson (1997: 137).

§***Caloplaca tominii*** (Savicz) Ahlner

Locality 2: alt. 330 m, in open wind exposed *Papaveretum radicatae* vegetation influenced by bird excrements, on silty soil, 29 July 1992. **Locality 3a:** alt. 30 m, in open *Poa glauca-Puccinellia angustata* vegetation on north-west facing slope, on weakly saline, silty soil with drought cracks, 3 Aug. 1999. – Previous records from the Canadian Arctic are shown in Thomson (1997: 175).

§***Caloplaca xanthostigmoidea*** (Räsänen) Zahlbr., Syn. *C. epiphyta* Lynge

Locality 2: alt. 340 m, in *Carici-Dryadetum integrifoliae* vegetation, on mosses and plant debris, 26 July 1992; *ibid.*, alt. 330 m, in late wet, partly by shallow streaming water, inundated snowbed vegetation with *Saxifraga flagellaris* and many other *Saxifraga* species on shallow acidic soil over stones, on mosses and plant debris, 27 July 1992; *ibid.,* alt. 350 m, in dry, wind exposed *Papaveretum radicatae* vegetation, on mosses and plant debris, 28 July 1992. – Previous record from the Canadian Arctic, also from Ellesmere Island, is shown in Søchting and Tønsberg (1997: 252). Additional Canadian specimen in CANL: Nunavut, Bathurst Island, Polar Bear Pass area, 75°43'N, 98°25'W, gravelly limestone tundra, 21 July 1973, I. M. Brodo 19387, with R. R. Ireland, det. C. M. Wetmore, 1999.

Cercidospora stereocaulorum (Arnold) Hafellner

Locality 3b: alt. 900 m, in wind exposed polar desert vegetation, on *Stereocaulon* cf. *glareosum* (Savicz) H. Magn. (thallus: pinkish stem), associated with *Lasiosphaeriopsis stereocaulicola* (Linds.) O. E. Erikss. & R. Sant., 30 July 1999; *ibid.,* on *Stereocaulon* cf. *rivulorum* H. Magn. thallus: stem), 30 July 1999. **Locality 3c:** alt. 180 m, in *Carici-Dryadetum* vegetation, on *Stereocaulon depressum* (Frey) I. M. Lamb (thallus: stem, phyllocladia), 30 July 1999. **Locality 4:** alt. 60 m, in black crust dominated late snowbed vegatation with small herbs (*Saxifraga flagellaris* and *Phippsia algida*), on *Stereocaulon rivulorum* (swollen phyllocladia), 1 Aug. 1999. – Previous Canadian record: British Columbia (Alstrup and Cole, 1998).

§***Dacampia hookeri*** (Borrer) A. Massal.

Locality 4: alt. 60 m, in black crust dominated late snowbed with small herbs (*Saxifraga flagellaris* and *Phippsia algida*), 1 Aug. 1999. – Previous Canadian record: Alberta (Henssen, 1995). Additional Canadian specimens in CANL: Nunavut, Bathurst Island, Polar Bear Pass, 75°43'N, 98°25'W, on *Collema* sp., 8 July 1975, D. W. Vaneyk; *ibid.,* on *Solorina* sp., 18 July 1973, I. M. Brodo 1923.

*****Dacampia rufescentis*** (Vouaux) D. Hawksw.

Locality 3a: alt. 60 m, in *Hypno-Cassiopetum tetragonae* early snow bed vegetation on the sheltered slope of marine terraces, on *Peltigera rufescens* (Weiss) Humb. (thallus: upper surface), 2 Aug. 1999. – This fungus has previously been reported from Scandinavia, England and Spain (Hawksworth, 1986; Santesson, 1993; Martínez and Hafellner, 1998).

****Dactylospora deminuta*** (Th. Fr.) Triebel

Locality 3c: alt. 180 m, in hummocky *Hypno-Cassiopetum tetragonae* vegetation in early snowbed, on *Lecanora epibryon* (thallus), 31 July 1999. **Locality 4:** alt. 60 m, in *Hypno-Cassiopetum tetragonae* vegetation, on

Lecanora epibryon (Ach.) Ach. (thallus), 1 Aug. 1999. – This is a common fungus growing on various terricolous lichens in the Arctic (Triebel, 1989; Zhurbenko & Santesson, 1996).

Echinothecium reticulatum Zopf

Locality 4: alt. 80 m, in fell-field vegetation, on *Arctoparmelia separata* (Th. Fr.) Hale thallus), 1 Aug. 1999. – Previous Canadian records: British Columbia (Alstrup and Hawksworth, 1990; Alstrup and Cole, 1998).

Graphium aphthosae Alstrup & D. Hawksw.

Locality 3c: alt. 180 m, in hummocky *Hypno-Cassiopetum tetragonae* vegetation in early snowbed, on *Peltigera aphthosa* (L.) Willd. (thallus: upper surface, cephalodia), 31 July 1999. – Previous Canadian record: British Columbia (Alstrup and Cole, 1998).

§***Gypsoplaca macrophylla*** (Zahlbr.) Timdal

Locality 2: alt. 360 m, in dry *Papaveretum radicatae* vegetation on exposed coarse stony substrate, on sandy soil, 24 July 1992; *ibid.,* alt. 340 m, in *Saxifraga tricuspidata* vegetation under wind-exposed plateau, on gravelly, sandy soil, 29 July 1992. – Previous records from the Canadian Arctic are summarized in Timdal (1990) and shown in Brodo *et al.* (2001: 330).

*****Lasiosphaeriopsis stereocaulicola*** (Linds.) O. E. Erikss. & R. Sant.

Locality 1b: alt. 125 m, in snow flush site with many mosses, on *Stereocaulon alpinum* Laurer *ex* Funck thallus: stem), 6 Aug. 1999. **Locality 3b:** alt. 900 m, in wind exposed polar desert vegetation, on *Stereocaulon* cf. *glareosum* (thallus: stem), associated with *Cercidospora stereocaulorum,* 30 July 1999. **Locality 3c:** alt. 160 m, in *Carici-Dryadetum* vegetation, on *Stereocaulon depressum* (thallus: stem), associated with *Taeniolella christiansenii* Alstrup & D. Hawksw., 30 July 1999. – This fungus is fairly common on *Stereocaulon* species in the Arctic and is also known from Scandinavia, Faroes, Iceland, Austria, Uganda and Argentina (Eriksson and Santesson, 1986; Alstrup and Hawksworth, 1990; Alstrup and Elvebakk, 1996; Zhurbenko and Santesson, 1996; Alstrup *et al.,* 1994; Karatygin *et al.,* 1999; Berger, 2000).

§***Lecanora geophila*** (Th. Fr.) Poelt

Locality 2: alt. 335 m, in moraine, on sandy soil, rather abundant, 1 Aug. 1992. – Previous records from the Canadian Arctic are shown in Thomson (1997: 283). Additional Canadian specimens in CANL: Nunavut, Ellesmere Island, John Peninsula, 2 miles SE of Alexandra Fjord Post, 78°52’N, 75°55’W, 20 July 1979, M. J. Shchepanek 79-50, det. P. Y. Wong; Nunavut, Baffin Island, 85 km SW of Nanisivik, 73°00’N, 84°40’W, P. Y. Wong 4667, with P. Budkerwitsch, det. P. Y. Wong.

Muellerella pygmaea (Körber) D. Hawksw. var. ***athallina*** (Müll. Arg.) Triebel

Locality 1a: alt. 75 m, in polar desert on stony gravelly soil, on *Lecanora marginata* (Schaer.) Hertel & Rambold (thallus), 3 Aug. 1992. **Locality 2:** alt. 700 m, dolomitic plateau bordering the pass to the north, in polar desert vegetation, on *Lecanora marginata* (thallus), 23 July 1992. – Previous Canadian records: Saskatchewan, Northwest Territories (Triebel, 1989). Additional Canadian specimens in CANL: British Columbia, Queen Charlotte Islands, Moresbey Island, San Cristoval Range, on *Amygdalaria* spp., I. M. Brodo 12275, 26809.

Muellerella pygmaea (Körber) D. Hawksw. s. lat.

Locality 2: alt. 310 m, in temporarily moist *Carici-Dryadetum* vegetation, on *Xanthoria elegans* (Link) Th. Fr. (mostly apothecia, also thallus), 31 July 1992. **Locality 4:** alt. 70 m, in moraine, on *Xanthoria elegans* (mostly apothecia, also thallus), 1 Aug. 1999. – *Muellerella pygmaea s. lat.* has been reported from British Columbia by Aptroot (1996) and Alstrup and Cole (1998). Additional Canadian specimen of *M. pygmaea s. lat.* in CANL: Yukon, on *Ophioparma ventosa* (L.) Norman var. *lapponica* (Räsänen) R. Sant., 9 July 1975, Ostafichuk 5394.

§***Neuropogon sphacelatus*** (R. Br.) Alstrup & E. S. Hansen

Locality 3b: alt. 900 m, in wind exposed polar desert vegetation on rock outcrop, 30 July 1999. – Previous records from the Canadian Arctic are shown in Thomson (1984: 286).

Phaeosporobolus alpinus R. Sant., Alstrup & D. Hawksw.

Locality 2: alt. 360 m, in *Hypno-Cassiopetum tetragonae* vegetation in erosion gully in moraine on acidic substrate, on *Pertusaria dactylina* (Ach.) Nyl. (thallus), 27 July 1992. – Previous Canadian records: British Columbia (Alstrup and Cole, 1998), Manitoba (Alstrup and Hawksworth, 1990).

Phaeosporobolus usneae D. Hawksw. & Hafellner

Locality 2: alt. 320 m, in *Papaveretum radicatae* vegetation in moraine, on *Evernia perfragilis* Llano (thallus), 31 July 1992; *ibid.*, on *Flavocetraria nivalis* (L.) Kärnefelt & A. Thell (thallus), 31 July 1992; *ibid.*, alt. 340 m, in dry *Papaveretum radicatae* vegetation on exposed coarse stony substrate, on *Flavocetraria nivalis* (thallus), 24 July 1992; *ibid.*, alt. 310 m, in *Carici-Dryadetum* vegetation in the valley bottom of the pass, on *Flavocetraria nivalis* (thallus), 28 July 1992; *ibid.*, alt. 320 m, in *Saxifraga tricuspidata* vegetation, on *Flavocetraria nivalis* (thallus), 29, 31 July 1992; *ibid.*, alt. 700 m, in polar desert vegetation on dolomitic plateau bordering the pass, on *Evernia perfragilis* (thallus), 23 July 1992. **Locality 3b:** alt. 900 m, in wind exposed polar desert vegetation, on *Evernia perfragilis* (thallus), 30 July 1999. Heavily infected thallus portions of *Flavocetraria nivalis* become dark grey. This is a new host for *Phaeosporobolus usneae.* – Previous Canadian records: British Columbia (Alstrup and Cole, 1998), Quebec (Cole and Hawksworth, 2001), Ontario (Hafellner *et al.*, 2002).

Polycoccum trypethelioides (Th. Fr.) R. Sant.

Locality 2: alt. 315 m, in *Hypno-Cassiopetum tetragonae* vegetation in gully in moraine, on *Stereocaulon alpinum* (thallus: stem), 24 July 1992. – Previous Canadian record: British Columbia (Alstrup and Cole, 1998).

*****Pronectria solorinae*** Lowen & R. Sant. ined.

Locality 3b: alt. 900 m, in wind exposed polar desert vegetation, on *Solorina bispora* Nyl. morph with external cephalodia (apothecia: hymenium), 30 July 1999. – This fungus has earlier been reported from Austria (Hafellner, 1999), Sweden (Santesson, 1993), and the Russian Arctic (Zhurbenko and Santesson, 1996).

§****Psora luridella*** (Tuck.) Fink

Locality 2: alt. 335 m, in *Papaveretum radicatae* vegetation on sandy soil in moraine, 27 July 1992. – Timdal (1986: 263) in his revison of the lichen genus *Psora* in North America reported *P. luridella* only from the extra-Arctic territory of the U.S.A. However occurrence of the species in the dry sandy (in a way "steppe-like") habitats in the Arctic, accompanied by such lichen species as *Caloplaca tominii* and *Gypsoplaca macrophylla*, is not surprising in our view. *Psora luridella* is fairly common and abundant in desert-steppe landscapes of central Asia (Zhurbenko, 2003), where it is sometimes accompanied by the abovementioned lichen species.

Sphaerellothecium araneosum (Rehm ex Arnold) Zopf s. lat., Syn. *Echinothecium glabrum* M.S. Christ., Alstrup & D. Hawksw.

Locality 1b: alt. 125 m, in moss-rich *Cetrarietum delisei* vegetation on stony gravel, on *Cladonia pocillum* (Ach.) Grognot (thallus: primary squamules), 6 Aug. 1999. **Locality 2:** in *Carici-Dryadetum* vegetation, on *Cladonia pocillum* (thallus: primary squamules), 31 July 1992. – According to Roux and Triebel (1994: 520) this species grows on *Ochrolechia, Pertusaria* and *Varicellaria* lichen host genera. However Alstrup and Hawksworth (1990: 28) reported it growing also on *Cladonia pocillum* (thallus: primary squamules) and we follow here their broader host concept of the fungus. Previous Canadian records: British Columbia (Goward *et al.,* 1994; Alstrup and Cole, 1998).

*****Stigmidium croceae*** (Arnold) Roux & Triebel

Locality 2: alt. 330 m, in late snowbed site partly inundated by trickling melting water, with *Saxifraga flagellaris* and many other *Saxifraga* species on shallow acidic soil over stones, on *Solorina bispora*, morph with external cephalodia (thallus), 27 July 1992; *ibid.,* alt. 345 m, in *Hypno-Cassiopetum tetragonae* vegetation, on *Solorina bispora* (thallus), 27 July 1992. – This is a rarely reported species, which has previously been known from Austria (Roux and Triebel, 1994).

****Stigmidium frigidum*** (Sacc.) Alstrup & D. Hawksw.

Locality 2: alt. 300 m, in *Carici-Dryadetum* vegetation, on *Thamnolia vermicularis* (Sw.) Schaer. var. *subuliformis* (Ehrh.) Schaer. (thallus), 28 July 1992. – This is a rather common fungus growing on *Thamnolia vermicularis* in the arctic and alpine areas of the Northern Hemisphere (Alstrup and Hawksworth, 1990; Santesson, 1993; Hafellner, 1994; Zhurbenko and Santesson, 1996).

*****Taeniolella christiansenii*** Alstrup & D. Hawksw.

Locality 3b: alt. 900 m, in wind exposed polar desert vegetation, on *Stereocaulon depressum* (thallus: phyllocladia), associated with *Lasiosphaeriopsis stereocaulicola,* 30 July 1999. – This is an apparently rare fungus, previously known from Greenland and the Russian Arctic (Alstrup and Hawksworth, 1990; Karatygin *et al.,* 1999).

Thamnogalla crombiei (Mudd) D. Hawksw.

Locality 1a: alt. 75 m, in semi-polar desert vegetation on *Thamnolia vermicularis* var. *subuliformis* (thallus), 3 Aug. 1992. **Locality 1b:** alt. 125 m, in mossy snow flush area, on *Thamnolia vermicularis* var. *subuliformis* (thallus), 6 Aug. 1999. – This gall-inducing fungus has been sporadically reported on *Thamnolia vermicularis* from both hemispheres (Hawksworth, 1980; Triebel *et al.,* 1991; Santesson, 1993; Hoffmann and Hafellner, 2000).

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REFERENCES

Alstrup, V. and Hawksworth, D.L. (1990). The lichenicolous fungi of Greenland. Meddelelser om Grönland, BioScience 31: 1–90.

Alstrup, V. and Cole, M.S. (1998). Lichenicolous fungi of British Columbia. The Bryologist 101: 221–229.

Alstrup, V. and Elvebakk, A. (1996). Part 5. Fungi III. Lichenicolous fungi. In: A. Elvebakk & P. Prestrud (eds.) A catalogue of Svalbard plants, fungi, algae and cyanobacteria. Norsk Polarinstitutt Skrifter 198: 261–270.

Alstrup, V., Christensen, S.N., Hansen, E.S. and Svane, S. (1994). The lichens of the Faroes. Fródskaparrit 40: 61–121.

Alstrup, V., Hansen, E.S. and Daniëls F.J.A. (2000). Lichenized, lichenicolous and other fungi from North and North-East Greenland. Folia Cryptogamica Estonica 37: 1–20.

Aptroot, A. (1996). New records of lichens and lichenicolous fungi from British Columbia. The Bryologist 99: 196–198.

Berger, F. (2000). Beitrag zur Kenntnis der Flechten un lichenicolen Pilze Islands. Acta Botanica Islandica 13: 69–82.

Bergeron, J-F. and Svoboda, J. (1989). Plant communities of Sverdrup Pass, Ellesmere Island, N.W.T. Musk-Ox 37: 76–85.

Brodo, I.M. (1995). Lichens and lichenicolous fungi of the Queen Charlotte Islands, British Columbia, Canada. 1. Introduction and new records for B. C., Canada and North America. Mycotaxon 56: 135–173.

Brodo, I.M, Sharnoff S.D. and Sharnoff, S. (2001). *Lichens of North America.* Yale University Press, New Haven and London, USA.

Cole, M.S. and Hawksworth, D.L. (2001). Lichenicolous fungi, mainly from the USA, including *Patriciomyces* gen. nov. Mycotaxon 77: 305–338.

Daniëls, F.J.A., Bültmann, H., Lünterbusch, C. and Wilhelm, M. (2000). Vegetation zones and biodiversity of the North-American Arctic. Berichte der Reinhold-Tüxen-Gesellschaft. 12: 131–151.

Daniëls, F.J.A. and Wilhelm, M. (2002). On the way to an integrated vegetation map of Greenland, pp. 22-34. In *Fourth International Circumpolar Arctic Vegetation Mapping Workshop* (eds. M. K. Raynolds and C. J. Markon). U. S. Geological Survey, Open-File Report 02-181 (http://pubs.usgs.gov/of/2002/of02-181).

Diederich, P. (2003). New species and new records of American lichenicolous fungi. Herzogia 16: **–** (in press).

Eriksson, O. and Santesson, R. (1986). Lasiosphaeriopsis stereocaulicola. - Mycotaxon 25: 569–580.

Esslinger, T.L. (1997). *A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada.* North Dakota State University: http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (First Posted 1 December 1997, Most Recent Update 17 July 2002), Fargo, North Dakota, USA.

Geiser, L.H., Dillman, K., Derr, C.C. and Stensvold, M.C. (1998). Lichens and allied fungi of southeast Alaska. In: *Lichenographa Thomsoniana: North American lichenology in honor of John W. Thomson* (eds. M. G. Glenn, R. C. Harris, R. Dirig and M. S. Cole). Mycotaxon Press, Ithaca, New York, USA: 201–243.

Goffinet B. (1994). Floristic notes on the lichen and lichenicolous fungi flora of Alberta Canada. Mycotaxon 51: 1–4.

Gonzales, G., Gould, W.A. and Raynolds, M.K. (2000). *1999 Canadian Transect for the Circumpolar Arctic Vegetation Map. Data Report.* Northern Ecosystem Analysis and Mapping Laboratory, IAB, UAF and Arctic Field Ecology, University of Minnesota Itasca Biological Program: http://www.neaml.uaf.edu

Goward, T., and Thor, G. (1992). Notes on the lichens and allied fungi of British Columbia. I. The Bryologist 95: 33–37.

Goward, T., Diederich, P. and Rosentreter, R. (1994). Notes on the lichens and allied fungi of British Columbia. II. The Bryologist 97: 56–62.

Goward, T., Breuss, O., Ryan, B., McCune, B., Sipman, H. and Scheidegger, C. (1996). Notes on the lichens and allied fungi of British Columbia. III. The Bryologist 99: 439–449.

Hafellner, J. (1994). Beiträge zu einem Prodromus der lichenicolen Pilze Österreichs und angrenzender Gebiete. I. Einige neue oder seltene Arten. Herzogia 10: 1–28.

Hafellner, J. (1999). Beiträge zu einem Prodromus der lichenicolen pilze Österreichs und angrenzender Gebiete. IV. Drei neue Arten und weitere bemerkenswerte Funde hauptsächlich in der Steiermark. Linzer Biologische Beitrage 31(1): 507–532.

Hafellner, J., Triebel, D., Ryan, B.D. and Nash III, T.H. (2002). On lichenicolous fungi from North America. II. Mycotaxon 84: 293–329.

Hawksworth, D.L. (1980). Notes on British lichenicolous fungi: III. Notes from the Royal Botanical Garden Edinburgh 38: 165–183.

Hawksworth, D.L. (1986) Notes on British lichenicolous fungi: V. Notes from the Royal Botanic Garden Edinburgh 43: 497–519.

Henssen, A. (1995). Studies on the biology and structure of *Dacampia* (Dothideales), a genus with lichenized and lichenicolous species. Cryptogamic Botany 5(2): 149–158.

Hoffmann, N. and Hafellner, J. (2000) Eine Revision der lichenicolen Arten der Sammelgattungen Guignardia und Physalospora (Ascomycotina). Bibliotheca Lichenologica 77: 1–181.

Karatygin, I.V., Nezdoiminogo, E.L., Novozhilov, Y.K. and Zhurbenko, M.P. (1999). *Russian Arctic Fungi. Annotated Checklist.* Khimiko-farmatsevticheskaya Academiya Press, St. Petersburg, Russia.

Kojima, S. (1991). Vegetation and environment of the Canadian High Arctic with special reference to Cornwallis Island. Proceedings of the National Institute of Polar Research, Symposium Polar Biology 4: 135–154.

Levesque, E. (1997) *Plant distribution and colonization in extreme polar deserts, Ellesmere Island, Canada.* Ph. D. thesis. University of Toronto, Canada.

Martínez, I. and Hafellner, J. (1998). Lichens and lichenicolous fungi on Peltigerales in the Iberian Peninsula and the Canary Islands. Mycotaxon 69: 271–310.

Noble, W.J., Ahti, T., Otto, G.F. and Brodo, I.M. (1987). A second checklist and bibliography of the lichens and allied fungi of British Columbia. Syllogeus 61: 1–95.

Roux, C. and Triebel, D. (1994). Révision des espèces de Stigmidium et de Sphaerellothecium (champignons lichénicoles non lichénisés, Ascomycetes) correspondant à Pharcidia epicymatia sensu Keissler ou à *Stigmidium schaereri* auct. Bulletin de la Société Linéenne de Provence 45: 451–542.

Santesson, R. (1993). *The lichens and lichenicolous fungi of Sweden and Norway.* SBT-förlaget, Lund, Sweden.

Scholz, P. (1998). *Phacopsis doerfeltii* sp. nov. and two other interesting lichenicolous fungi from Canada. Sauteria 9: 37–42.

Søchting, U. and Tønsberg, T (1997). Caloplaca xanthostigmoidea (Räs.) Zahlbr., a common lichen in cool regions of the northern hemisphere. Acta Univ. Ups. *Symb. Bot. Ups.* 32(1): 247–253.

Thomson, J.W. (1984). *American Arctic Lichens. 1. The Macrolichens.* Columbia University Press, New York, USA.

Thomson, J.W. (1997). *American Arctic Lichens. 2. The Microlichens.* The University of Wisconsin Press, Madison.

Timdal, E. (1986). A revision of *Psora* (Lecideaceae) in North America. The Bryologist 89: 253–275.

Timdal, E. (1990). Gypsoplacaceae and *Gypsoplaca,* a new family and genus of squamiform lichens. In: *Contributions to Lichenology in Honour of A. Henssen* H. (ed. M. Jahns). Bibliotheca Lichenologica 38: 419–427.

Triebel, D. (1989). Lecideicole Ascomyceten. Eine Revision der obligat lichenicolen Ascomyceten auf lecideoiden Flechten. Bibliotheca Lichenologica 35: 1–278.

Triebel, D., Rambold, G. and Nash, TH, III. (1991) On lichenicolous fungi from continental North America. Mycotaxon 42: 263–296.

Zhurbenko, M.P. (2003). New and rare lichen species from Sakha-Yakutiya Republic and Magadan Region of Russia. Botanicheskii Zhurnal [St.Petersburg] 88 (1): 111–118.

Zhurbenko, M.P., Santesson, R., Walker, D.A., Auerbach, N.A. and Lewis, B. (1995). New and interesting lichenicolous fungi and lichens from Alaska. Evansia 12: 92–97.

Zhurbenko, M.P. and Santesson, R. (1996). Lichenicolous fungi from the Russian Arctic. Herzogia 12: 147–161.

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CONTRIBUTION TO THE STUDY OF THE GENUS CALVATIA (LYCOPERDACEAE) IN BRAZIL

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ABSTRACT - Additional data on species of *Calvatia* occurring in Brazil are presented: *Calvatia cyathiformis*, *C. depressa* (new record for Brazil), *C. excipuliformis* and *C. fumosa* (new record for Brazil). A key of the species in Brazil is provided and the spore ornamentation under SEM is illustrated.

KEYWORDS - Gasteromycetes, SEM-photographs, neotropics, taxonomy

INTRODUCTION

Fries (1849) established the genus *Calvatia*, initially including only *C. craniiformis* (Schwein.) Fr. (= *Bovista craniiformis* Schwein.). Later, Morgan (1890) revised and emended the genus, incorporating other species which were previously in *Lycoperdon*. Currently, the genus comprises about 35 species having a broad geographical distribution (Kirk et al. 2001); some of these species are encountered in artic regions (Lange 1990) whereas others are in the desert (Lange 1993). The genus is characterized by its large and epigeous basidiomata, with a globose or turbinate form, opening by irregular fissures and a pulverulent gleba with capillitium similar to that found in *Lycoperdon* Pers.

Previous to the present study nine species of *Calvatia* were recorded from Brazil, by Rick (1930, 1961), Silveira (1943) and Bononi et al. (1981): *C. caelata* (Bull.) Morgan, *C. craniiformis* (Schwein.) Fr., *C. cruciata* (Rostk.) Fr., C. *cyathiformis* (Bosc) Morgan, *C. excipuliformis* (Scop.) Perdeck, *C. fragilis* (Vittad.) Morgan, *C. maxima* (Schaeff.) Morgan, *C. rubroflava* (Cargin) Lloyd, *C. saccata* (Vahl) Morgan. Some of these species are edible (Liu 1984, Pegler et al. 1995), others synthesize antibiotic and anti-carcinogenic substances (Beneke 1963, Gasco et al. 1974, Umezawa et al. 1975, Jong & Donovick 1989). This work describes the *Calvatia* species found in several poorly investigated tropical ecosystems. Our goal is to obtain a better understanding of the diversity within this group of fungi.

MATERIALS AND METHODS

Fieldwork was based at the ecological stations of Jataí (21°33′-21°37′S and 48°45′-48°51′W) and Itirapina (22°28′-22°30S and 48°17′-48°19′W) and the biological reserve of Moji-Guaçu (22°15′-22°16′S and 47°08′-47°-12′W), all located in the state of São Paulo; plus the biological reserves of Serra Negra (8°38′-8°35′S and 38°02′-38°04′W) and Gurjaú (8°21´30´´-8°12´S and 31°56´30´´-35°45´W), both lying in the state of Pernambuco.

Hand-cut sections of fresh and dried material were mounted for microscopical examination in 2% KOH, Melzer's reagent and lactophenol with cotton blue. Spore measurements, examined in a Philips XL 20 Scanning Electron Microscope (SEM), include the ornamentation. Colour terms in parenthesis are those of Kornerup & Wanscher (1978). Herbarium names are abbreviated according to the Index Herbariorum (Holmgren et al., 1990). The material studied is preserved in SP and URM.

TAXONOMIC SECTION

Key of the species of *Calvatia* in the present study

1 Basidiomata with sterile base absent or small 2
1' Basidiomata with sterile base well developed 3

2 Basidiomata depressed-globose or turbinate; capillitium threads not pitted; spores 3.5–4 μm diam., finely spinulose .... *C. depressa*
2' Basidiomata globose or subglobose, capillitium threads pitted; spores 4–4.5 μm diam., verrucose .... *C. fumosa*

3 Basidiomata reddish brown (KW 9E5), exoperidium granular; spores 4-6 μm diam., strongly spinose .... *C. cyathiformis*
3' Basidiomata brownish grey (KW 5E8) or dark brown (KW 7E8), exoperidium smooth; spores 3.5-4 μm diam., verrucose ....*C. excipuliformis*

Descriptions of the species

Calvatia cyathiformis (Bosc) Morgan, J. Cin. Soc. Nat. Hist. 12: 168, 1890. Fig.1
Basionym: *L. cyathiforme* Bosc, Berl. Mag. D. Ges. Naturf. Freunde 5: 87, 1811.

Basidiomata 5–8 cm broad, 8–13 high, turbinate; exoperidium smooth, reddish-brown (KW 9E5), very thin, fragile, cracking in irregular flakes and soon disappearing; endoperidium thin, not persistent, sterile base well developed, chambered, persistent; capillitium threads 3–5 μm diam., sparsely branched, rather thick-walled, with numerous pits, septate, pale brown; spores 4-6 μm diam., strongly spinose, pale purplish.

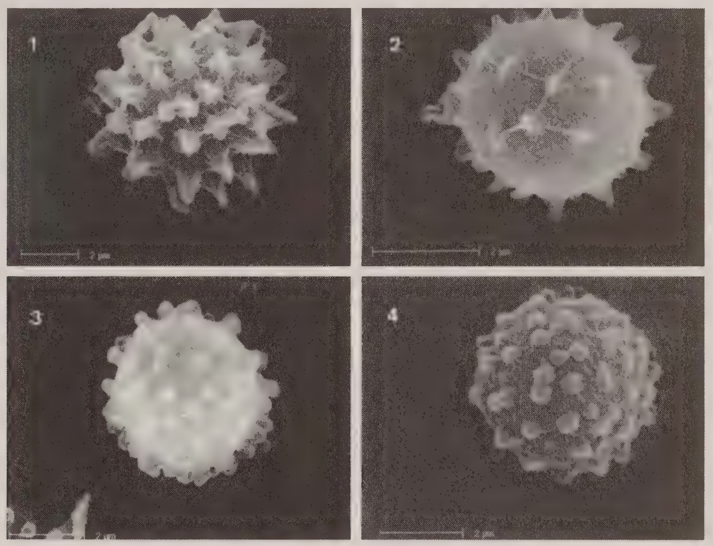
Material studied: Brazil, São Paulo state, Itirapina ecological station, 31/I/1999 (SP 307551), cerrado vegetation; Moji-Guaçu biological reserve, 15/III/1999 (SP 307550), cerrado vegetation; Pernambuco state, Gurjaú ecological station, 20/III/2003 (URM 77082), atlantic rain forest.

Additional material studied: Nigeria, Ibadan, IV/1967, det. J. Westseijn (SP 107397).

Habitat: Solitary in litter and on soil.

Distribution: United States of America (Coker & Couch 1928, Zeller 1947, Zeller & Smith 1964), South Africa (Bottomley 1948), Panama (Garner 1956), Pakistan (Eckblad 1957), Africa (Dring 1964), Spain (Calonge & Demoulin 1975), Afghanistan (Watling & Gregory 1977), China (Liu 1984), Mongolia (Dörfelt & Bum_aa 1986), Mexico (Chio et al. 1990, Pardavé 1991), Belgium (Moyersoen & Demoulin 1996).

Remarks: Macroscopically this species can be easily confused with *Calvatia excipuliformis* and *C. rubroflava* by the basidiomata colouration and by the presence of a well-developed sterile base. However, it differs microscopically mainly in spore size and ornamentation. When observed under SEM the spore sculpturing consists of long irregular spines, the surface of the spore and the spine being very rough. There are some studies relating the presence of mycoproteins with anti-tumor properties (Jong & Donovick 1989).



Figures 1-4. SEM-photographs of the spores: 1. *Calvatia cyathiformis*; 2. *C. depressa*; 3. *C. excipuliformis*; 4. *C. fumosa*

Calvatia depressa (Bonord.) Zeller & A.H. Smith, Lloydia 27 (3): 171, 1964. Fig. 2
Basionym: *Lycoperdon depressum* Bonord., Bot. Zeitg.: 611, 1837.

Basidiomata 2–3 cm broad, 2·5–3·5 high, depressed-globose or turbinate; exoperidium smooth, light brown (KW 4D2) or reddish-brown (KW 7E8), thin, fragile, cracking in irregular flakes; endoperidium thin, not persistent, sterile base reduced, compact, persistent; capillitium threads 2–3 µm diam., sparsely branched, rather thick-walled, not pitted, septate, pale brown; spores 3·5–4 µm diam., spinose, pale brown.

Material studied: Brazil, São Paulo state, Itirapina ecological station, 31/I/1999 (SP 307555), cerrado vegetation; Moji-Guaçu biological reserve, 04/I/2000 (SP 307554), cerrado vegetation; Jataí ecological station, 09/III/2000 (SP 307553), cerrado vegetation.

Additional material studied: Brazil, São Paulo state, 28/X/1967, det. G. Guzmán (SP 71289).

Habitat: Solitary on soil.

Distribution: United States of America (Coker & Couch 1928, Zeller & Smith 1964), France (Demoulin 1983).

Remarks: This species can be characterized mainly by the basidiomata which are depressed-globose or turbinate, light or reddish brown, the sterile base is reduced, capillitium threads are not pitted and spore ornamentation which, when observed under SEM, comprises isolated coarse pyramidal spines; connections between the spines may occur. This is the first record of *C. depressa* from Brazil.

Calvatia excipuliformis (Pers.: Pers.) Perdeck, Blumea 6: 490, 1950. Fig. 3
Basionym: *Lycoperdon polymorphum* var. *excipuliforme* Scop., Fl. Carn. 2: 488, 1772.

Basidiomata 5·5–7 cm broad, 7–9 high, turbinate; exoperidium granular, brownish-grey (KW 5E8) or dark brown (KW 7E8), thin, cracking in irregular parts; endoperidium thin, not persistent, sterile base well developed, chambered, persistent; capillitium threads 4–5 µm diam., branched, rather thick-walled, pitted, sparsely septate, pale brown; spores 3·5–4 µm diam., verrucose, pale brown.

Material studied: Brazil, São Paulo state, Jataí ecological station, 03/III/2001 (SP 307559), cerrado vegetation.

Additional material studied: England, Burnham Beeches, 13/VIII/1966, det. N. H. Sinnott (SP 107398; SP 107399).

Habitat: Solitary on soil.

Distribution: Argentine (Spegazzini 1927), Norway (Eckblad 1955), USA (Zeller & Smith 1964), Belgium (Demoulin 1968, Moyersoen & Demoulin 1996), Spain (Calonge & Demoulin 1975), France (Demoulin 1983).

Remarks: *C. excipuliformis* is fundamentally recognized by the basidiomata with dark coloration and spore ornamentation that, when observed under SEM, comprises columnar warts with a cylindrical apex; connections between the warts may occur.

Calvatia fumosa Zeller, Mycologia 39: 300, 1947. Fig. 4

Basidiomata 2·5–3·5 cm broad, 2·5–3 high, globose or subglobose; exoperidium smooth, dark grey (KW 3F3), thin, fragile, cracking in irregular flakes; endoperidium thin, not persistent, sterile base reduced, compact; capillitium threads 3–4 µm diam., branched, thin-walled, sparsely pitted, septate, brown; spores 4–4·5 µm diam., verrucose, brown.

Material studied: Brazil, Pernambuco state, Serra Negra biological reserve, 19/IV/2002, coll. & det. Baseia (URM 398900), caatinga vegetation. São Paulo state, Itirapina ecological station, 30/I/1999 (SP 307560).

Additional material studied: United States of America, Oregon, 20/VII/1949, det. W. B. Cooke (SP 60018).

Habitat: In groups in litter.

Distribution: United States of America (Zeller 1947, Zeller & Smith 1964), Mexico (Pardavé 1991).

Remarks: This species can be segregated by the globose or subglobose basidiomata with dark colouration and spore ornamentation which, when observed under SEM, comprises rounded warts unevenly distributed, sometimes confluent. The surface of the spore is rough, not smooth. This constitutes the first record of *C. fumosa* from Brazil

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LITERATURE

Bononi, V. L. R.; Trufem, S. F. B. & Grandi, R. A. P. 1981. Fungos macroscópicos do Parque Estadual das Fontes do Ipiranga, São Paulo, Brasil. *Rickia* **9**: 37-53.

Bottomley, A. M. 1948. Gasteromycetes of South África. *Bothalia* **4**: 473-810.

Beneke, E. S. 1963. *Calvatia*, calvacin and cancer. *Mycologia* **55**: 257-270.

Calonge, F. D. & Demoulin, V. 1975. Les Gastéromycètes d'Espagne. *Bull. Soc. Myc. Franc.* **91**: 247-292.

Chio, R. E., Guzmán, G. & Bandala, V. M. 1990. Hongos del Estado de México, III. Especies citadas en la bibliografia: Gasteromycetes. *Rev. Mex. Mic.* **6**: 207-220.

Coker, W. C. & Couch, J. N. 1928. *The Gasteromycetes of Eastern United States and Canada.* Chapel Hill, p. 201.

Demoulin, V. 1968. Gastéromycètes de Belgique: Sclerodermatales, Tulostomatales, Lycoperdales. *Bull. Jard. Bot. Nat. Belg.* **38**: 1-101.

Demoulin, V. 1983. Un site remarquable pour ses Gastéromyètes: les grès rouges permiens du nord Massif des Maures (Var, France). *Cryptogamie, Mycologie* **4**: 9-17.

Dörfelt, H. & Bum_aa, D. 1986. Die Gasteromyceten (Bauchpilze) der Mongolischen Volksrepublik. *Nova Hedwigia* **43**: 87-111.

Dring, D. M. 1964. Gasteromycetes of West Tropical Africa. *Mycological Papers* **98**: 1-60.

Eckblad, F. E. 1955. The Gasteromycetes of Norway. The Epigaean Genera. *Nytt Mag. Bot.* **4**: 19-86.

Eckblad, F. E. 1957. Some Gasteromycetes from Tirich Mir, Citral State, Western Pakistan *Nytt Mag. Bot.* **5**: 37-39.

Fries, E. M. 1849. *Summa Vegetabilium Scandinaviae* **2**: 442.

Garner, J. H. B. 1956. Gasteromycetes from Panama and Costa Rica. *Mycologia* **48**: 757-764.

Gasco, S.; Serafino, A.; Mortarini, V. & Menziani, E. 1974. An antibacterial and antifungal compound from *Calvatia lilacina. Tetrahedron Lett.*: 3431-3432.

Holmgren, P. K.; Holmgren, N. H. & Barnett, L. C. 1990. Index Herbariorum. Part I. Herbaria of the world. 8th edn. Regnum Vegetabile 120. New York Botanical Garden, New York (http://www.nybg.org/bsci/ih/ih.html).

Jong, S. C. & Donovick, R. 1989. Antitumor and Antiviral Substances from Fungi. *Advanc. Appl. Microb.* **34**: 183-262.

Kirk, P. M., P. F. Cannon, J. C. David & Stalpers, J. A. 2001. *Ainsworth & Bisby´s Dictionary of the Fungi*. Ninth Edition, CAB International, UK (http://biodiversity.uno.edu/~fungi/).

Kornerup, A. & Wanscher, J. H. (1978). *Methuen Handbook of Colour*, 3th edn., Eyre Methuen, London, 252 pp.

Lange, M. 1990. Arctic Gasteromycetes II. *Calvatia* in Greenland, Svalbard and Iceland. *Nord. J. Bot.* **9**: 525-546.

Lange, M. 1993. Classifications in the *Calvatia* group. *Blyttia* **51**: 141-144.

Liu, B. 1984. The Gasteromycetes of China. *Beiheftezur, Nova Hedwigia* **74**: 1-235.

Morgan, A. P. 1890. North American Fungi. The Gasteromycetes. *Journ. Cinc. Soc. Nat. Hist.* **12**: 163-172.

Moyersoen, B. & Demoulin, V. 1996. Les Gastéromycètes de Corse: Taxonomie, Écologie, Chorologie. *Lejeunia* **152**: 1-129.

Pardavé, L. M. 1991. Gasteromicetos del Estado de Aguascalientes. *Rev. Mex. Mic.* **7**: 71-78.

Pegler, D. N.; Laessøe, T. & Spooner, B. N. 1995. British puffballs, earthstars and stinkhorns, an account of the British gasteroid fungi. Royal Botanic Gardens, Kew. 211 pp.

Rick, J. 1930. Lycoperdineas Riograndensis. *Egatea* **15**(3): 121-127.

Rick, J. 1961. Basidiomycetes Eubasidii no Rio Grande do Sul. Brasília. *Iheringia* **9**: 451-480.

Silveira, V. D. 1943. O gênero *Calvatia* no Brasil. *Rodriguésia* **16**: 63-80.

Spegazzini, C. 1927. Gasteromycetas Argentinas. *Physis* **8**: 421-437.

Umezawa, H.; Takeuchi, T.; Linuma, H.; Ito, M.; Ishizuka, M.; Kurakata, Y.; Umeda, Y.; Nakanishi, Y.; Nakamara, T.; Obayashi, A. & Tanabe, O. 1975. A new antibiotic, calvatic acid. *J. Antibiot.* **28**: 87-90.

Watling, R. & Gregory, N. M. 1977. Larger fungi from Turkey, Iran and neighbouring countries. *Karstenia* **17**: 59-72.

Zeller, S. M. 1947. More Notes on Gasteromycetes. *Mycologia* **39**: 282-312.

Zeller, S. M. & Smith, A. H. 1964. The genus *Calvatia* in North America. *Lloydia* **27**: 148-186.

MYCOTAXON

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ARRHENIA EBURNEA SP. NOV. FROM SPAIN

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Abstract: *Arrhenia eburnea*, an omphalinoid fibulate fungus, is described as a new species. It is characterized by pale basidiomata (white, ivory to yellowish-white), deeply decurrent lamellae, membranal and incrusting pigment of the pileipellis and shape and size of spores. The most similar in outward appearance and macroscopic morphology is the blue-green species *Arrhenia chlorocyanea*, but the new taxon clearly differs from it in the colour of the basidiomata, type of pigment of the pileipellis and spore size. It is also similar in colour to *Omphalina luteopallida* but differs from it in habit, glabrous stipe and tetrasporic basidia. The inclusion of species with pale basidiomata (white, ivory, yellowish-white to ochraceous-white) in the concept of the genus *Arrhenia* is discussed and the new combination *Arrhenia luteopallida* is also proposed.

Key words: Tricholomataceae, Agaricales, Basidiomycota, taxonomy

INTRODUCTION

During a taxonomic revision of the species of *Arrhenia* Fr. and related genera (e.g. *Lichenomphalia* Redhead, Lutzoni, Moncalvo & Vilgalys, *Omphalina* Quél.) in the Iberian Peninsula (Barrasa & Rico 2001, 2003), an omphalinoid, non-lichenized fungus with white, ivory to yellowish-white basidiomata was collected growing on moist soil among short mosses.

Recent phylogenetic analyses for agarics have been suggested solutions for systematic treatment of the core omphalinoid genera in the Agaricales (Moncalvo *et. al.* 2002; Redhead *et. al.* 2002). Consequently, omphalinoid fungus previously included in *Omphalina s. l.* have been reevaluated and the new genus *Lichenomphalia* was proposed for lichenized former omphalinas and the concept for the bryophilous species of *Arrhenia* and *Omphalina* was emended. Thus, many of the species previously included in *Omphalina s. l.* with greyish, blackish, bluish or brown-grey pileus and stipe and concolorous hymenia were transferred to *Arrhenia*. However, species with reddish brown, rusty, vinaceous brown or orangish brown pileus and stipe with non-concolorous hymenia were retained in *Omphalina* (Redhead *et. al.* 2002).

The colour of *A. eburnea* should be more similar to those of the species actually accommodate under the genus *Chrysomphalina* Clémençon, in which bright yellowish pigments have been usually reported (Norvell *et al.*, 1994; Bon, 1997). However, important micromorphological features of the hymenium of *Chrysomphalina* (see Clemençon, 1982; Kost 1986), as well as the absence of clamps and strictly lignicolus habit, differentiate this genus from *Arrhenia* and *Omphalina* (Norvell *et al.*, 1994; Redhead *et al.*, 2002). This criterion has been supported by recent phylogenic analyses based on molecular data, and *Chrysomphalina*, *Arrhenia* and *Omphalina* are placed in distant clades (Moncalvo *et al.*, 2002).

The bryophilous omphalinoid habit, lamellate hymenium concolorous with pileus and stipe, irregular hymenophoral trama, presence of clamps, membranal to weakly incrusting pigment of pileipellis, lack of cystidia, and non-amyloid spores of the new species, justify its inclusion in the genus *Arrhenia*. Although white, ivory to yellowish-white basidiomata were not reported for the members included under the emended concept of *Arrhenia* (Redhead *et al.*, 2002), a large variation in the colour of *Arrhenia acerosa* (Fr.) Kühner var. *acerosa* was described in specimens from the Netherlands (Kuyper, 1995) and from the Iberian Peninsula (Barrasa & Rico, 2003). In this way, grey, grey-brown, dark grey or fuscous fructifications was observed together with pale grey, whitish to almost white basidiomata of *A. acerosa*. Therefore, an enlarged range of colours for the species of *Arrhenia*, including white to yellow hues, is here suggested to adapt the concept of the genus.

The white, ivory to yellowish-white basidiomata, deeply decurrent lamellae, glabrous stipe, membranal to weakly incrusting pigment of the pileipellis, tetrasporic basidia and size and shape of spores, justify the description of *A. eburnea* as a new species.

MATERIALS AND METHODS

The material studied is deposited in AH. Drawings were made with a camera lucida device coupled to an Olympus BX 50 microscope. For mycological concepts and terminology we followed Vellinga (1988) and Kirk *et al.* (2001). Colour of the basidiomata were determined according to Munsell (1994). Spore size was based on 30 measurements of at least one basidiome of each studied collection. Comparative spore shape and size between taxa was established following the Q method of Heinemann and Rammeloo (1985). Extreme values have been noted between brackets when they represented no more than 10 % of the measurements.

Materials used for comparison: *Arrhenia chlorocyanea* (Pat.) Redhead, Lutzoni, Moncalvo & Vilgalys: **SPAIN: Castilla-León, Segovia:** Fresno de Cantespino, Urbanización Prado Pinilla, 30TVL5676, 1050 m, on clayey soil between lichens (*Cladonia* sp.) and bryophytes, 26-X-2002, *J. M. Barrasa* (AH 31501). **Castilla-La Mancha, Toledo:** Almorox, 30TUK8256, 580 m, slope with *Cladonia* sp., 13-IX-1999, *M. Villarreal & R. Izquierdo* (AH 30505). *Omphalina luteopallida* Kuyper & Hauskn.: **AUSTRIA: Niederösterreich:** Röschitz, in colle Galgenberg, MTB 7361/1, 26-X-1987, *A. Hausknecht* (WU 7454-holotype).

TAXONOMY

Arrhenia eburnea **Barrasa & V. J. Rico sp. nov.** **(Figs. 1-5)**

Basidiomata parva 7·5-15 x 3-7 mm, omphalinoidea. Pileus 3-7 mm latus, applanatus vel subconvexus, centro paulo depressus e pulverulentus, margine subcrenato, albus vel flavo-albidus, exsiccatus pallide isabellinus. Stipes 6-12 x 0·5-1 mm, rectus vel curvatus, centralis, cylindraceus, superne leviter incrassatus, concoloribus, glaber. Lamellae triangulares, c. 11 stipitem attingentes, 1-2 mm latae, molles vel furcatae, longe decurrentes, albidae. Lamellulae rarae praesentes. Caro tenuis, alba. Odore saporeque nulli.

Basida 20-35 x 6-7·5 µm, subcylindrica vel clavata, 4-sporigera, sterigmatibus 4-4·5µm longis. Sporae 9-11·5(-12) × 4·5-6·5 µm, cylindraceo-lacrymoideae, basi apiculatae, leves, hyalinae, inamyloideae. Cystidia himenialia nulla. Pileipellis ex hyphis cylindraceis cutem formantibus 5-6 µm latis, pigmento heterogeneum, minute incrustatis. Hyphae fibulatae.

TYPUS: **SPAIN: Castilla-La Mancha, Toledo:** La Iglesuela, El Bonal, 440-460 m, 30TUK525575, on moist sandy soil, among bryophytes, 17-IV-2002, *M. Villarreal* (AH 30508-holotypus).

Basidiomata 7·5-15 × 3-7 mm, omphalinoid, lamellate. *Pileus* 3-7 mm diam, applanate to slightly convex, slightly depressed and tomentose at the centre, margin sinuate, white to ivory or yellowish-white when moist, white (2·5Y 8/1) to pale yellow (2·5Y 8/3 and 8/4) or light yellowish-brown in lamellae edge and pileus margins (2·5Y 6/4) when drying. *Stipe* 6-12 × 0·5-1 mm, central, cylindrical, becoming broader towards the lamellae, straight to slightly sinuose, smooth, fragile, concolorous with pileus. *Lamellae* triangular, distant (L = 11), up to 1·2 mm broad, simple to furcate, deeply decurrent reaching ± the middle of the stipe, white to concolorous with pileus and stipe. *Lamellulae* rare or absent. *Context* thin, concolorous with surface. *Smell* and taste absent.

Basidia 20-35 × 6-7·5 µm, subcylindrical to clavate, 4-spored, sterigmata straight to slightly curved and 4-4·5 µm long. *Basidiospores* 9-11·5(-12) × 4·5-6·5 µm, Q = 1·61-2·1, Qav = 1·87, ellipsoid to subcylindrical with suprahilar depression (lacrymoid) (*cf.* Vellinga, 1988), with acute to confluent base, smooth, hyaline, non-amyloid. *Cystidia* absent. *Pileipellis* a cutis of slightly interwoven hyphae, hyphae 5-6 µm diam, with membranal irregularly distributed pigment, and minutely incrusted pigment in some hyphae. *Clamps* present in all tissues.

Etymology. From latin *eburneus-ea*, referring to the white with yellowish hues (ivory, yellowish-white, pale yellow, light yellowish-brown) of the basidiomata.

Habitat and distribution. *Arrhenia eburnea* is only known from the type locality, a *Quercus ilex* subsp. *ballota* (Desf.) Samp. open forest ("dehesa") with *Juniperus oxycedrus* L., and with a shrubland mainly constituted by *Cistus ladanifer* L., *Cytisus scoparius* (L.) Link and *Lavandula stoechas* subsp. *sampaiana* Rozeira. Those forests represents the typical vegetation of the mesomediterranean belt, with subhumid ombroclimate, of the Mediterranean Region in Central-West Spain (Rivas-Martínez, 1987). The new species fructified on sandy acid soil among short mosses.

DISCUSSION

Arrhenia eburnea is quite different from other species of the genus. The most similar in outward appearance is the blue-greenish species *A. chorocyanea* (Pat.) Redhead, Lutzoni, Moncalvo & Vilgalys but *A. eburnea* clearly differs from it in the colour of basidiomata, deeply decurrent lamellae, weakly incrusting pigment of pileipellis and size of spores (Tab. 1). Since a true ivory or yellowish-white pigmentation is present in *Arrhenia eburnea*, we can reject the possibility that the studied material of the new species could represents an albino variant of the blue-green *A. chlorocyanea*.

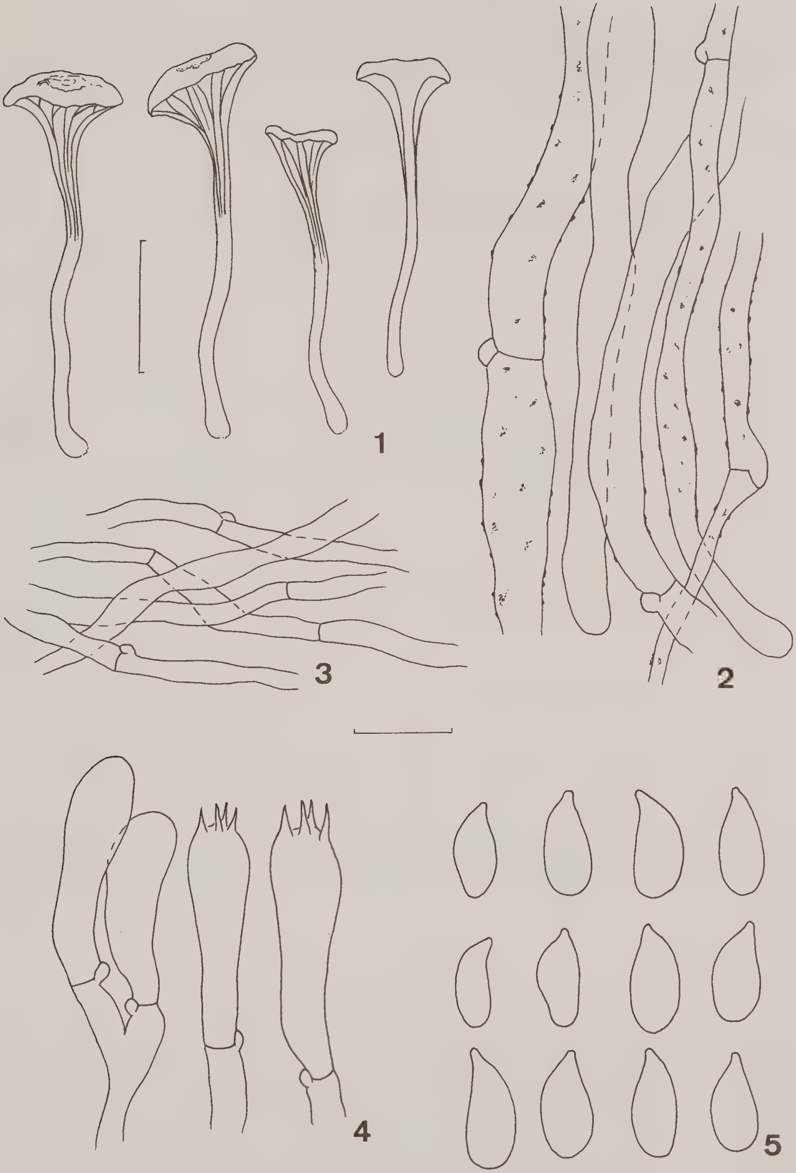
The colour of *Omphalina luteopallida* Kuyper & Hauskn. is very similar to those of *A. eburnea*, but it differs from the former in the deeply decurrent lamellae that cover the upper half of the stipe, glabrous stipe, tetrasporic basidia, and size and shape of spores (Tab. 1). *Omphalina luteopallida* is mainly characterized by the presence of bisporic basidia and by its hairy stipe. After examination of type material no pileo-, cheilo- or pleurocystidia were observed, and we consider that the caulocystidia reported in the original description of *O. luteopallida* (Kuyper & Hausknecht, 1997: 52, Fig. 4) are not true cystidia but simple hyphae ends that give a tomentose appearance to stipe. After the revaluation of the concept of *Arrhenia* and *Omphalina* (Redhead *et al.*, 2002), one of the most noteworthy morphological feature of this genera is the absence of any type of cystidia in the fungal tissues.

Since grey to greyish brown hues are predominant in the species of *Arrhenia* (Redhead, *et al.*, 2002), the description of the new species *A. eburnea* would imply that white, ivory to yellowish-white hues should be also included in the colour range for the emended concept of *Arrhenia*. Consequently, we proposed the following new combination:

Arrhenia luteopallida **(Kuyper & Hauskn.) Barrasa & V. J. Rico comb. nov.**
≡ *Omphalina luteopallida* Kuyper & Hauskn., *Österr. Z. Pilz.* **6:** 52. 1997 (basionym).

TABLE 1. Main distinguishing characters between *Arrhenia eburnea*, *A. chlorocyanea* and *A. luteopallida*.

	Arrhenia eburnea	*Arrhenia chlorocyanea*	*Arrhenia luteopallida*
Colour of Basidiomata (dry)	white, ivory to yellowish-white	blue-green	white, ivory to yellowish-white or ochraceous-white
Lamellae	deeply decurrent, reaching the middle of the stipe	decurrent, but never reaching the middle of the stipe	decurrent, but never reaching the middle of the stipe
Stipe	glabrous	glabrous	hairy
Pigment of pileipellis	membranal and weakly incrusting	membranal and incrusting	weakly incrusting
Basidia	tetrasporic	tetrasporic	bisporic
Spore size (µm)	9-11·5(12) × 4·5-6·5	7-9·5(10) × 4-5	7·5-11·5(12) × 4-5·5(6)



FIGS. 1-5. *Arrhenia eburnea* Barrasa & V. J. Rico (AH 30508-holotype). **1.** Basidiomata. **2.** Pileipellis. **3.** Hymenophoral trama. **4.** Basidia and basidioles. **5.** Spores. Scale bars: 1 = 5 mm; 2-5 = 10 μm.

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REFERENCES

Barrasa, J. M. & Rico, V. J. (2001). Lichenized species of *Omphalina* (*Tricholomataceae*) in the Iberian Peninsula. *Lichenologist* **33:** 371-386.

Barrasa, J. M. & Rico, V. J. (2003). The non-omphalinoid species of *Arrhenia* in the Iberian Peninsula. *Mycologia* **95:** in press.

Bon, M. (1997). Flore Mycologique d'Europe 4. Les Clitocybes, Omphales et resemblants. *Tricholomataceae*-2ème partie. Sous-famille *Clitocyboideae* (Fayod) M. Bon. *Doc. Mycol., Mém. Hors sér.* **4:** 1-181.

Clemençon, H. (1982). Kompendium der Bläterpilze. Europaische omphalinoide Tricholomataceae. *Z. Mykol.* **48:** 195-237.

Heinemann, P. & Rammeloo, J. (1985). De la mesure des spores et son expression. *Agarica* **6:** 366-380.

Kirk, P. M., Cannon, P. F., David, J. C. & Stalpers, J. A. (2001). *Ainsworth and Bisby's Dictionary of the Fungi. 9th Edn.* Wallingford: CAB International, 655 p.

Kost, G. (1986). Zur Gültigkeit der Gattung *Chrysomphalina* Clç. *Z. Mykol.* **52:** 233.

Kuyper, T. W. (1995). *Omphalina* Quél. In: C. Bas, T. W. Kuyper, M. E. Noordeloos & E. C. Vellinga (eds.). *Flora Agaricina Neerlandica*, vol. 3: 78-88. Rotterdam: A. A. Balkema.

Kuyper, T. W. & Hausknecht, A. (1997). *Omphalina luteopallida*, eine neue Art aus Österreich. *Österr. Z. Pilzk.* **6:** 51-54 + Farbige Abb. III.

Moncalvo, J.-M., Vilgalys, R., Redhead, S. A., Johnson, J. E, James, T. Y., Aime, M. C., Hofstetter, V., Verduin, S. J. W., Larsson, E., Baroni, T. J., Thorn, R. G., Jacobsson, S., Clémençon, H. & Miller Jr., O. K. (2002). One hundred and seventeen clades of euagarics. *Molec. Phylogenetics Evol.* **23:** 357-400.

Munsell®. (1994). *Soil Color Charts*. New York: Macbeth Division of Kollmorgen Instruments Corporation.

Norvell, L. L., Redhead, S. A. & Ammirati, J. F. (1994). *Omphalina* sensu lato in North America 1-2. 1: *Omphalina wynniae* and the genus *Chrysomphalia*. 2: *Omphalina* sensu Bigelow. *Mycotaxon* **50:** 379-407.

Redhead, S. A., Lutzoni, F., Moncalvo, J.-M. & Vilgalys, R. (2002). Phylogeny of agarics: partial systematics solutions for core omphalinoid genera in the Agaricales (euagarics). *Mycotaxon* **83:** 19-57.

Rivas-Martínez, S. (1987). *Mapa de las series de vegetación 1: 400 000 de España y memoria*. Madrid: ICONA, Série Técnica.

Vellinga, E. C. (1988). Glossary. In: C. Bas, T. W. Kuyper, M. E. Noordeloos & E. C. Vellinga (eds.). *Flora Agaricina Neerlandica*, vol. 1: 54-64. Rotterdam: A. A. Balkema.

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MYCOSPHAERELLA VERATRI-LOBELIANI (ASCOMYCETES), SP. NOV.

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ABSTRACT

Mycosphaerella veratri-lobeliani on *Veratrum album* subsp. *lobelianum* is described as a new species. The name *Sphaerella veratri* Losa is reduced to a synonym of *Mycosphaerella veratri-lobeliani*.

KEYWORDS: fungi of Bulgaria, *Mycosphaerella,* taxonomy, *Veratrum*

In the present article, a new species of *Mycosphaerella* on *Veratrum* is described. Its type specimen was examined under a light microscope after mounting in lactophenol solution. The nomenclature of the known *Mycosphaerella* spp. on *Veratrum* is discussed.

NEW SPECIES

Mycosphaerella veratri-lobeliani Fakirova & Denchev, ***sp. nov.***

Pseudothecia usque 110 µm diam., plus minusve globosa, nigra, solitaria, subepidermalia. **Asci** numerosi, bitunicati, subsessiles, obpyriformes, 55–72 × 15–20 µm, 8-spori. **Ascosporae** fusiformes, hyalinae, laeves, 16.5–20 × 4.5–6.5 µm, in medio uniseptatae, ad septum non constrictae, guttulatae.

Holotypus: in foliis siccis Veratri albi L. subsp. lobeliani (Bernh.) Reichenb. (Liliaceae s.l.), Bulgaria, Regio Vitoschae, Mons Vitoscha, loco dicto 'Aleko', 20.X.1995, leg. V. Fakirova (SOMF 22 165).

Etymology: named after the host.

Pseudothecia up to 110 µm diam, more or less globose, black, scattered singly, subepidermal, immersed in tissue of leaves. Peridium consisting of 2-3 layers of dark-walled, slightly flattened polygonal cells, 9–11 µm diam. **Asci** numerous, bitunicate, subsessile, obpyriform, 55–72 × 15–20 µm, 8-spored. **Ascospores** fusiform, hyaline, smooth, 16.5–20 × 4.5–6.5 µm, 1-septate in the middle, not constricted at the septum, guttulate.

Specimen examined: on overwintered leaves of *Veratrum album* L. subsp. *lobelianum* (Bernh.) Reichenb. (*V. lobelianum* Bernh.), Bulgaria, Mt. Vitosha, Aleko locality, 20 Oct 1995, leg. V. Fakirova (SOMF 22 165 – Holotype).

Distribution: Bulgaria and Spain.

Mycosphaerella on *Veratrum* is currently represented by *M. veratri* Höhn. on *Veratrum album* (Höhnel 1914) and *Sphaerella veratri* Losa on the same host (Losa 1948). *Mycosphaerella veratri* is originally described possessing asci 44 × 7–8 µm and ascospores 8–10 × 2.5–3 µm. The measurements of *M. veratri* in the world monograph of *Mycosphaerella* (Tomilin 1979: 151) are based on a study of Russian specimens. Tomilin (op. cit.) measured asci 32–36 (–42) × 8–10 µm and ascospores 8–10 × 2–3 µm. *Sphaerella veratri* is originally described possessing asci 65–75 × 14–15 µm and ascospores 18 × 5–5.5 µm. Our attempts to locate the holotype of *S. veratri* were unsuccessful. The Bulgarian specimen of *Mycosphaerella* on *Veratrum album* subsp. *lobelianum* seems to be morphologically close to *Sphaerella veratri* Losa while the measurements of the asci and ascospores distinguished that Bulgarian specimen from *Mycosphaerella veratri* Höhn. Because of this, as well as of a nomenclature reason (s. the next paragraph) herein was described a new species, *Mycosphaerella veratri-lobeliani.*

NOMENCLATURE OF *MYCOSPHAERELLA* SPECIES ON *VERATRUM*

It is necessary to clarify some nomenclature problems about the known *Mycosphaerella* spp. on *Veratrum.* In 1914 Höhnel (1914: 108) validly described a new *Mycosphaerella* sp. on the leaves of *Veratrum album,* viz. *M. veratri.* In 1928 Trotter listed that name in Saccardo's index, *Sylloge Fungorum* (Trotter 1928: 876). Actually, Trotter has not only listed the Höhnel's species but he has transferred it into *Sphaerella.* Trotter ascribed the name to Höhnel but in accordance with the ICBN (Art. 46.4) that new combination must be attributed to Trotter, viz. *Sphaerella veratri* (Höhn.) Trotter. In the recent taxonomic scheme of *Mycosphaerella* (Corlett 1991; Kirk *et al.* 2001), *Sphaerella* Ces. & De Not. was reduced to a synonym of *Mycosphaerella. Sphaerella veratri* Losa must be regarded as an illegitimate name (ICBN, Art. 53.1). For that taxon another combination was proposed, viz. *Mycosphaerella veratri* (Losa) M. Morelet. However, this combination is also illegitimate because the cited basionym of that combination is not a correct name, also according to ICBN (Art. 53.1). Consequently, herein we reduce both *Sphaerella veratri* Losa and *Mycosphaerella veratri* (Losa) M. Morelet to synonyms of *Mycosphaerella veratri-lobeliani.*

Mycosphaerella veratri-lobeliani Fakirova & Denchev, 2003.

[= *Sphaerella veratri* Losa, Anales Jard. Bot. Madrid **8**: 304, 1948, *nom. illeg.* (a later homonym, ICBN, Art. 53.1), non *S. veratri* (Höhn.) Trotter, Syll. Fungorum **24:** 876, 1928. — Type: on *Veratrum album,* Spain, Valle de Nuria, VI.1946]

[≡ *Mycosphaerella veratri* (Losa) M. Morelet, Ann. Soc. Sci. Nat. Archéol. Toulon Var **20**: 106, 1968, *nom. illeg.* (a later homonym, ICBN, Art. 53.1), non *M. veratri* Höhn., Sitzungsber. Kaiserl. Acad. Wiss., Math.-Naturwiss. Cl., Abt. 1, **123**: 108, 1914]

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LITERATURE CITED

Corlett, M. 1991. An annotated list of the published names in *Mycosphaerella* and *Sphaerella.* – Mycol. Memoir **18**: 1-328.

Höhnel, F. von 1914. Fragmente zur Mykologie (Nr. 848). – Sitzungsber. Kaiserl. Acad. Wiss., Math.-Naturwiss. Cl., Abt. 1, **123**: 108.

Kirk, P.M., Cannon, P.F., David, J.C. & Stalpers, J.A., eds. 2001. Dictionary of the fungi. 9th edn. – CAB International, Wallingford.

Losa, M. 1948. Micromicetos del Pirineo Español. – Anales Jard. Bot. Madrid **8**[1947]: 297-338.

Tomilin B.A. 1979. [Guide to the fungi of the genus *Mycosphaerella* Johans.] – Nauka, Leningrad. (In Russian)

Trotter, A. 1928. *Sphaerella veratri.* – In: Saccardo, P.A. *et al.* (eds.). Sylloge fungorum. Vol. **24**. Sectio II. Supplementum universale, pars X. Pyrenomycetae p.p., Discomycetae, Appendix. (Addenda ad vol. 23-24). Pp. 876-877. Pergola, Abellini.

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DIACHEOPSIS SPINOSIFILA, A SYNONYM OF LEPIDODERMA DIDERMOIDES

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Abstract: The types of *Lepidoderma didermoides* and *Diacheopsis spinosifila* have been compared applying electron microscopy techniques and synonymy is proposed.

Key words: chorology, nivicolous Myxomycetes, SEM, taxonomy

INTRODUCTION

We have already indicated in previous occasions how important it is to revise the type material of the nivicolous Myxomycetes, in order to specify accurately the macroscopic and microscopic characteristics of the species described from this particular habitat.

Once their characteristics are known and understood, including spore ornamentation applying electron microscopy techniques, it would be a suitable moment for the study of the distribution of these nivicolous species in the different mountain systems of the world in order to specify their distribution or chorology.

These studies could lead to a more complete understanding of their ecology, such as the height at which they fructify, the months of fructification or the habitats where they develop.

As a result of our basic investigations we have been able to propose synonymies in the case of species which had been erroneously described mainly due to the sparce material or few collections which has caused misinterpretation of their morphological variability.

We have therefore proposed some synonymies such as that of *Trichia synspora* with *T. varia* (SINGER & al., 2003) and *Diderma nigrum* with *D. asteroides* (MORENO & al., 2003).

In this work we propose the synonymy of *Diacheopsis spinosifila*, a taxon based on a single malformed collection, with *Lepidoderma didermoides*.

MATERIALS AND METHODS

The collected material was studied with a binocular microscope and, after mounting in Hoyer's medium, with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares using a Zeiss DSM-950. SEM-preparation was made as indicated in MORENO et al. (2002).

TAXONOMY

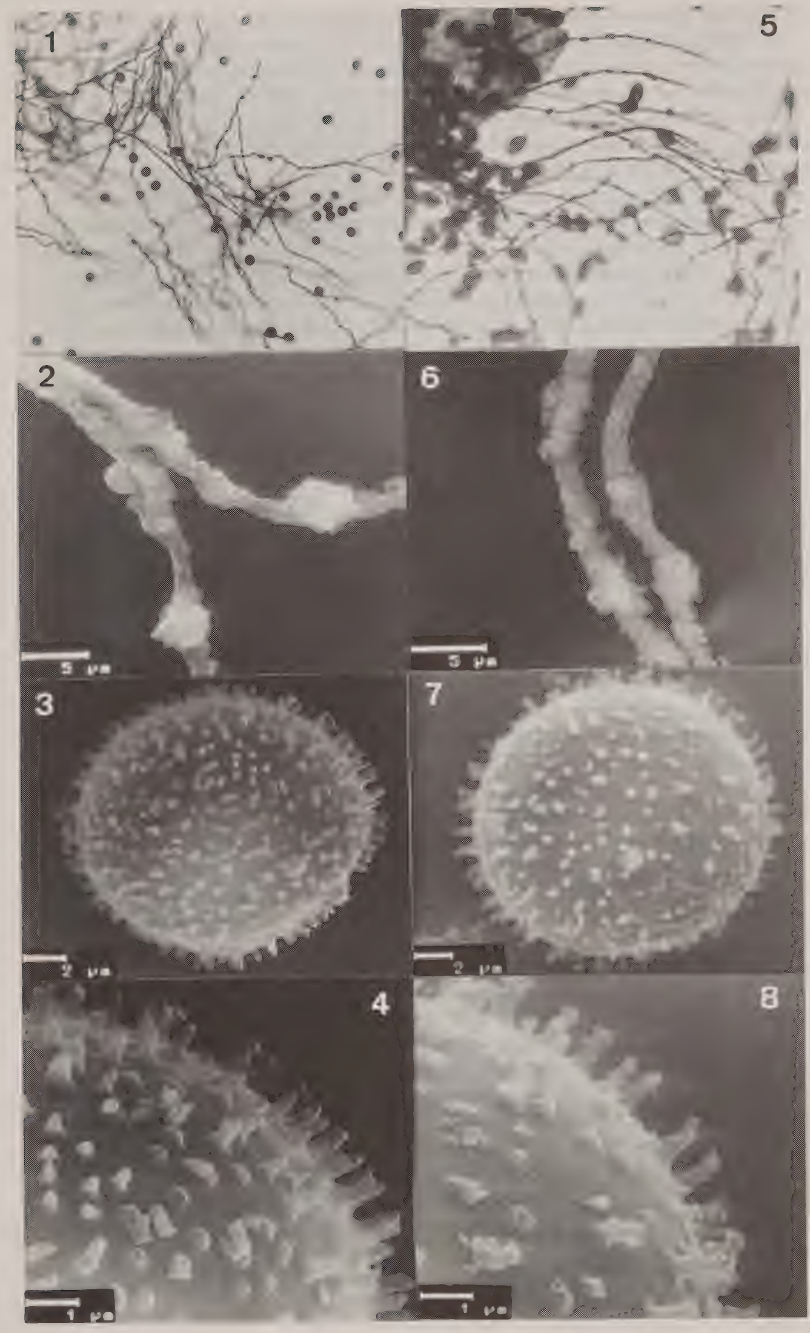
Diacheopsis spinosifila **M. L. Farr & R. L. Critchf.** *in* Farr, *Int. J. Mycol. Lichenol.* 3(2-3): 206. 1988. Figs. 1-4

Original diagnosis: Sporangia sessilia, raro subplasmodiocarpia, plumbea, dense gregaria vel aggregata, pulvinata, (1-)1.2-1.5(-2) mm diam. Hypothallus continuus, membranaceus, pallide brunneolus vel translucens. Peridium persistens, tenuimembranaceum, ± rugulosum, nitidum, raro vix iridescens, distratum; strato externo pallide brunneo ad stratum interius incoloratum arte adhaerenti. Capillitium atrobrunneum, extremis pallidis, filamentis maximam partem simplicibus 1-2.5 µm crassis, spinis obtusis ad 2 µm longis, nodulis atratis rotundis vel ovalis, et sectiones irregulariter ad 8 µm incrassatis notatis. Sporae luce reflexa et luce transmissa atrobrunneae, saepe area pallescenti praeditae, globosae vel late ovoideae, ellipsoideae, vel pyriformes, 14-17 µm diam, dense et aliquantum inaequaliter spinosae. Plasmodium ignotum.

The type material provided to us by the herbarium BPI consists of a box bearing the number 818265, which contains the holotype and part of the isotype. The holotype, with the number CA 5-112, is composed of a matchbox containing two pieces of coniferous wood with numerous sporocarps and a microscope slide with the same herbarium number. The isotype which, despite the different number CA 5-113 which, according to Critchfield, is a portion of the same collection, is not complete and consists only of a microscope slide. A note in the box states that the specimen of this slide was returned to Critchfield in July or August 1986. As indicated on the labels, both preparations were mounted in Amann medium and sealed with a type of varnish.

The sporocarps are clustered to aggregated, sessile, pulvinate to subglobose, sometimes distorted due to mutual pressure, seated on a broad more or less constricted base, 1-1.5 mm in diam., greyish black. Peridium persistent, simple, membranous, translucent, silvery to silvery grey, iridescent, light yellow to yellowish brown by transmitted light, smooth to rugulose, sometimes covered with small lime scales, white to brownish white, circular to slightly angular and widely scattered. Hypothallus thin, translucent to silvery iridescent, continuous, sometimes impregnated with lime scales from the peridium. Columella absent or, if present, irregularly globose. Capillitium (Figs. 1-2) consisting of straight to flexuous threads, 1-2 µm thick, dark brown, becoming pale at the tips, rarely branching, marked with globose to oval spiny nodules up to 8 µm diam. Spores (12-)14-17(-20) µm in diam., spinose, spines sometimes of irregular distribution, up to 1 µm long, sometimes without ornamentation, purplish black in mass, purplish brown in transmitted light. With SEM (Figs. 3-4) the ornamentation is formed by large baculae with more or less coralloid apices.

Figs. 1-4. *Diacheopsis spinosifila* (type). 1. Capillitium. 2. Capillitial nodes. 3. Spore. 4. Detail of spore ornamentation. **Figs. 5-8. *Lepidoderma didermoides* (type).** 5. Capillitium. 6. Capillitial nodes. 7. Spore. 8. Detail of spore ornamentation.


1
5
2
5 μm
6
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3
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7
2 μm
4
1 μm
8
1 μm

Lepidoderma didermoides **Kowalski**, *Mycologia* 63(3): 503. 1971. Figs. 5-8

Original diagnosis: Sporangiis dissipatis, sessilibus, hemisphaericus vel subglobosis, 1-1.5 mm diam.; peridio cartilaginoso, denso, aurantiaco-brunneis, squamulis minutissimis rarisis praesentis; hypothallo inconspicuo, tenuo perluciduo; columella prominenti, aurantiaca, hemisphaerica vel globosa; capillitio copioso, atropurpureo-brunneis ad apicem incoloratis, rugulosis; sporis globosis atrobrunneis, spinosis, 14-17 µm diam.; plasmodio ignoto.

The type material from the herbarium UC consists of eight twigs between four and seven centimetres long, abundantly covered with scattered to clustered sporocarps, sessile, seated on a broad more or less constricted base, subglobose, sometimes pulvinate, 1-1.5 mm in diam. Peridium double, persistent; endoperidium membranous, translucent, silvery grey, iridescent, light yellow to yellowish brown by transmitted light; exoperidium cartilaginous, thick, ochraceous brown to orange-brown, covered with small lime scales, white to brownish white, circular to slightly angular and widely scattered. Hypothallus well developed, cartilaginous, thick, concolorous with the exoperidium, continuous, impregnated with lime scales which have fallen from the exoperidium. Columella hemispherical to globose, frequently reduced to a slight elevation of the bases, sometimes absent. Capillitium (Figs. 5-6) formed by straight to flexuous threads, 1-2 µm thick, dark brown, pale at the tips, rarely branching, distinctly roughened, marked with irregular nodules up to 5 µm in diam. Spores globose, 14-17 µm in diam., purplish black in mass, purplish brown in transmitted light, spinose, the spines regularly distributed, up to 1 µm long. With SEM (Figs. 7-8) the ornamentation is composed by large baculae with more or less coralloid apices.

DISCUSSION AND CONCLUSIONS

Diacheopsis spinosifila is known only from the type collection from California and according to the authors is most closely related to *D. metallica*, from which it differs by its capillitium with its prominent markings. Nevertheless we doubt not only this relationship, but also the assignment to the genus *Diacheopsis*.

Meylan (1930) proposed the genus *Diacheopsis* basing it on one collection of *D. metallica*. He stressed the similarity to the genus *Diachea* because of its strongly iridescent peridium and its proximity to the genus *Lamproderma*, from which it differs mainly – and according to our opinion exclusively – by the absence of a columella.

Nevertheless we do observe a columella and do not agree in this respect with the original description of the authors of this species, who did not observe one. In some sporocarps we can distinguish a irregularly globose columella. Thus, we are not dealing with a species of *Diacheopsis*. There are further discrepancies with the original description, other than the presence of a columella. Neither with the magnifying glass, nor with the microscope, can we distinguish two peridial layers. We can observe only one single layer, membranous, translucent, silvery to silvery grey and iridescent. *Diacheopsis spinosifila* would be the only species of *Diacheopsis* with a double peridium. Also, we have to increase the range of the spore diameters given in the original diagnosis. Although the majority of the spores are between 14-17 µm, spores with 12 and 20 µm diam. can also be found and have to be taken into account. We also observe spores completely lacking ornamentation. Finally, we do not agree that the limy scales both on the sporocarps and on the substrate – in reality the cover of the hypothallus, and not directly the substrate – are "undoubtly incidental", as described by the authors.

Due to these facts we come to the following conclusions: As a columella is present we are definitely not dealing with a *Diacheopsis*, as already mentioned above. It is generally known that species of the genera *Diderma*, *Lepidoderma* and *Physarum* can lack lime completely when they are badly formed and then can appear very similar to a *Diacheopsis*. Therefore, a species based on one single collection, such as is the case of *D. spinosifila*, has to be treated with precaution. One has to be even more careful if there is a broad range of spore diameters and spore ornamentation, which sometimes is lacking completely. Without doubt this is a sign of an irregular fructification due to unfavourable environmental conditions, which is not unusual in the case of nivicolous Myxomycetes.

Thus we are dealing it with a badly formed species which has to be searched for in the genera *Diderma*, *Lepidoderma* or *Physarum*. Basing our comparison with species of these genera on the outstanding characters of this species, including the sculptured capillitium, the strongly ornamented spores, and taking in account the lime scales covering partly both sporocarps and hypothallus, we come to the conclusion that we are dealing with a limeless form of *Lepidoderma didermoides*.

Lepidoderma didermoides is a rare nivicolous species which is known only from the collections of Kowalski made in three different localities in Washington, from the branches of living shrubs, and there is one doubtful collection from Germany cited in three different works (KRIEGLSTEINER & G.J. KRIEGLSTEINER, 1990; NEUBERT & al., 1990; NEUBERT & al., 1995). There are more doubtful collections cited by TAMAYAMA (2000) from Japan.

The species coincides in both the macroscopic and the microscopic characters with *Diacheopsis spinosifila*. Its main characteristics are the double peridium covered with small scattered lime scales, its capillitium marked with large irregular nodules and its spores with spines up to 1 µm long. The lime scales coincide exactly with the scales found on *Diacheopsis spinosifila* as described incidentally by the authors. We observe in the type material of *Lepidoderma didermoides* that both the exoperidium and lime scales can sometimes be absent and no difference can be observed between this species and *Diacheopsis spinosifila*.

Thus, our taxonomic proposal according article 11.2 of the International Code of Botanical Nomenclature (GREUTER & al., 2000) is as follows:
***Lepidoderma didermoides* Kowalski**, *Mycologia* 63(3): 503. 1971.
= *Diacheopsis spinosifila* M. L. Farr & R. L. Critchf. *in* Farr, *Int. J. Mycol. Lichenol.* 3(2-3): 206. 1988.

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REFERENCES

GREUTER, W., J. McNEILL, F.R. BARRIE, H.M. BURDET, V. DEMOULIN, T.S. FILGUEIRAS, D.H. NICOLSON, P.C. SILVA, J.E. SKOG, P. TREHANE, N.J. TURLAND. & D.L. HAWKSWORTH (2000). *International Code of Botanical Nomenclature (Saint Louis Code).* Königstein. Koeltz Scientific Books, 474 pp.

KRIEGLSTEINER, L.T. & G.J. KRIEGLSTEINER (1990). Die Pilze Ost- und Nord-Württembergs. Funa Virtembergae ad orientem vergentis et septentrionalis Fungus Flora of Eastern and Northern Wuerttemberg. Teil II: Myxomyceten (Schleimpilze). *Beitr. Kenn. Pilze Mitteleurop.* 6: 119-230.

MEYLAN, C. (1930). Note sur un nouveau genre de Myxomycetes. *Bull. Soc. Vaud. Sc. Nat.* 57: 147-149.

MORENO, G., A. SÁNCHEZ, H. SINGER, C. ILLANA & A. CASTILLO (2002). *Fungi non delineati raro vel haud perspecte et explorate descripti aut definite picti. Pars XIX. A study on nivicolous Myxomycetes. The genus Lamproderma I.* Edizioni Candusso, 66 pp.

MORENO, G., H. SINGER, C. ILLANA & M. LIZÁRRAGA (2003). *Diderma nigrum*, a synonym of *Diderma asteroides* (Myxomycetes). *Österr. Z. Pilzk.* (in press).

NEUBERT, H., W. NOWOTNY & K. BAUMANN (1991). Myxomyceten aus Deutschland VII. (Mit Berücksichtigung von Vorkommen in Oberösterreich. *Carolinea* 49: 13-26.

NEUBERT, H., W. NOWOTNY, K. BAUMANN & H. MARX (1995). *Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs. Band 2: Physarales.* Gomaringen. Karlheinz Baumann Verlag. 368 pp.

SINGER, H., G. MORENO, C. ILLANA & M. LIZÁRRAGA (2003). *Trichia synspora*, a synonym of *Trichia varia*. *Mycotaxon* 87: 243-248.

TAMAYAMA, M. (2000). Nivicolous taxa of the Myxomycetes in Japan. *Stapfia* 73: 121-129.

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PHYTOPHTHORA NEMOROSA, A NEW SPECIES CAUSING CANKERS AND LEAF BLIGHT OF FOREST TREES IN CALIFORNIA AND OREGON, U.S.A.

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ABSTRACT

Phytophthora nemorosa, a new species isolated from stem cankers on two species of Fagaceae and leaves of various hosts, is described. The new species resembles *P. ilicis* with homothallic, amphigynous antheridia and deciduous, semi-papillate sporangia, and has a related ITS-DNA sequence. Symptoms and host range are similar to *P. ramorum*, cause of Sudden Oak Death and leaf blight and shoot dieback diseases in California and Oregon forests, although *P. nemorosa* does not appear to cause wide-spread mortality of oak trees.

KEY WORDS

Phytophthora ramorum, *Phytophthora ilicis*, *Lithocarpus densiflorus*, *Quercus agrifolia*, *Umbellularia californica*

INTRODUCTION

Phytophthora species are well known as pathogens of agricultural crops, and a few invasive and destructive forest species have been described, but the world's endemic *Phytophthora* flora is largely unexplored. Recent work with European oak forest soils (Jung et al. 2002, Hansen and Delatour 1999) and preliminary forest surveys in western North America (Hansen 2000), however, indicate that there is much to learn. In the course of the intensive survey effort and epidemiological research surrounding sudden oak death and *P. ramorum* in California and Oregon, we have encountered several *Phytophthora* species. One previously unknown species in particular was noteworthy for its aerial habit and frequency of isolation from plants also susceptible to *P. ramorum*. In this paper we describe this new

Phytophthora as *P. nemorosa*, a foliar and bole pathogen of various evergreen hardwood trees. It appears to be native to forests of western North America. Future papers will more fully describe its pathology and population biology. In previous accounts (Rizzo et al. 2002; Davidson et al. 2002), *P. nemorosa* was referred to as "P. ilicis-like."

METHODS

Phytophthora nemorosa was recovered from stem cankers and leaf lesions on corn meal agar amended with 10 ppm natamycin (Delvocid®), 200 ppm Na-ampicillin, 10ppm rifampicin, and 10 ppm dicloran (or 25 ppm Benlate) (PARP) or on a similar selective medium without dicloran or benomyl (CARP). Isolates of *Phytophthora ilicis* were recovered from infected English holly (*Ilex aquifolium*) leaves and stems by plating surface-disinfested (10% bleach 3 min., 3X rinse in sterile deionized water) pieces in PARP. Isolates were kept in sterile hemp seed water for long term storage.

Isolates were grown on Difco corn meal agar and V-8 agar amended with 30 ppm β-sitosterol (CMAβ, V8S), and fresh potato dextrose agar (fPDA). Sporangia were produced by transferring discs from margins of mycelium grown on V8S into natural stream water. Oogonia, oospores and antheridia were observed on cultures grown on CMA. Specimens were stained and mounted in lacto-glycerol/cotton blue, and measured on a Zeiss Universal microscope with 40X neofluar objective and eyepiece micrometer.

Pathogenicity on holly was tested by transferring small blocks of PDA with mycelium to the wounded (five parallel scratches) underside of English holly leaves borne on detached branches. Leaves were incubated at 17-18 C with 12 hr photoperiod at 100% relative humidity for 10 days (Buddenhagen and Young 1957).

Isolates of *P. nemorosa* used for DNA extraction were grown in potato dextrose broth at 14 C for 10 days. Genomic DNA was isolated from 75 mg of lyophilized mycelium using the following modified CTAB extraction procedure. Lyophilized tissue was pulverized in a FastPrep® instrument (Bio101, Carlsbad, CA) for 10 s at 5,000 rpm. Pulverized tissue was incubated in 500-ml CTAB on dry ice for 2 min, then thawed at 75 C for 2 min. This freeze-thaw step was repeated twice, with the final thaw for 30 min. DNA was purified in phenol:chloroform:isoamyl alcohol (25:24:1), further cleaned by using the Geneclean® Turbo Nucleic Acid Purification kit (Qiagen Inc, Valencia, CA) according to the manufacturer's instructions, and eluted in 30 μl ultra-pure water.

PCR was performed with primers ITS1 and ITS4 (White *et al.* 1990) as previously described (Bonants *et al.* 1997). Amplification products were sequenced with ITS1 and ITS4 as sequencing primers on an ABI 3100 genetic analyzer (Applied Biosystems, Foster City, CA). Published sequences of other *Phytophthora* species were downloaded from GenBank, aligned using the multialignment program Sequencher 4.1.2 and then visually optimized. Phylogenetic analysis was performed using PAUP* version 4.0b10 (Swofford 2000). A neighbor-joining tree was generated using the Kimura 2-parameter distance option (Kimura 1980) and midpoint rooting. Support for the internal branches was obtained by bootstrap analysis from 1000 replications.

SPECIES DESCRIPTION

Phytophthora nemorosa E.M. Hansen and Reeser

Species homothallica, oosporas in cultura procreans; oogoniis in medio 33 µm; antheridiis amphigynis. Sporangiis semipapillatis, in medio 51 x 37 µm. Sporangiis saepe deciduis, cum pedicellulo brevi (<5-20µm).
Homothallic, with amphigynous antheridia. Oogonia average 33 µm. Sporangia caducous, semi-papillate, average 51µm long by 37 µm wide, with short pedicels (<5-20 µm).

Type isolate: Isolate P-13, recovered from tanoak (*Lithocarpus densiflorus*) in Humboldt County CA is representative of the species and designated holotype. The type specimen (a dried agar culture) is deposited in the Oregon State University Mycological Herbarium (OSC # 104381), and a living culture is at ATCC (Accession # MYA-2948). Additional cultures are at CBS and University of California, Riverside. The ITS sequence is available on GenBank AY332651. Other isolates critically examined (Table 1, 2) include: 2052.1 from tanoak, Curry Co. OR; 2055.2 from tanoak, Curry Co. OR., GenBank AY332654; P7 from tanoak, Sonoma Co. CA., GenBank AY332652; and P11 from coast live oak (*Quercus agrifolia*), Contra Costa Co. CA., GenBank AY332653.

Etymology: *P. nemorosa* refers to the forest setting from which most isolates have been recovered.

Morphology: *P. nemorosa* is homothallic, producing terminal oogonia and oospores after 3 or 4 weeks in single culture on CMAβ (Figure 1). Oogonia average 33 µm (range 23 to 40 µm). Antheridia are amphigynous, about 13 x 13 µm (range 9-19 x 10-15) µm. Oospores are slightly aplerotic, averaging 29 µm (range 19 to 35 µm) (Table 1). Cultures on CMAβ

Table 1. Mean diameter of oogonia and oospores and length and width of antheridia for five isolates of *Phytophthora nemorosa*, (microns, +/- SD, n=10)

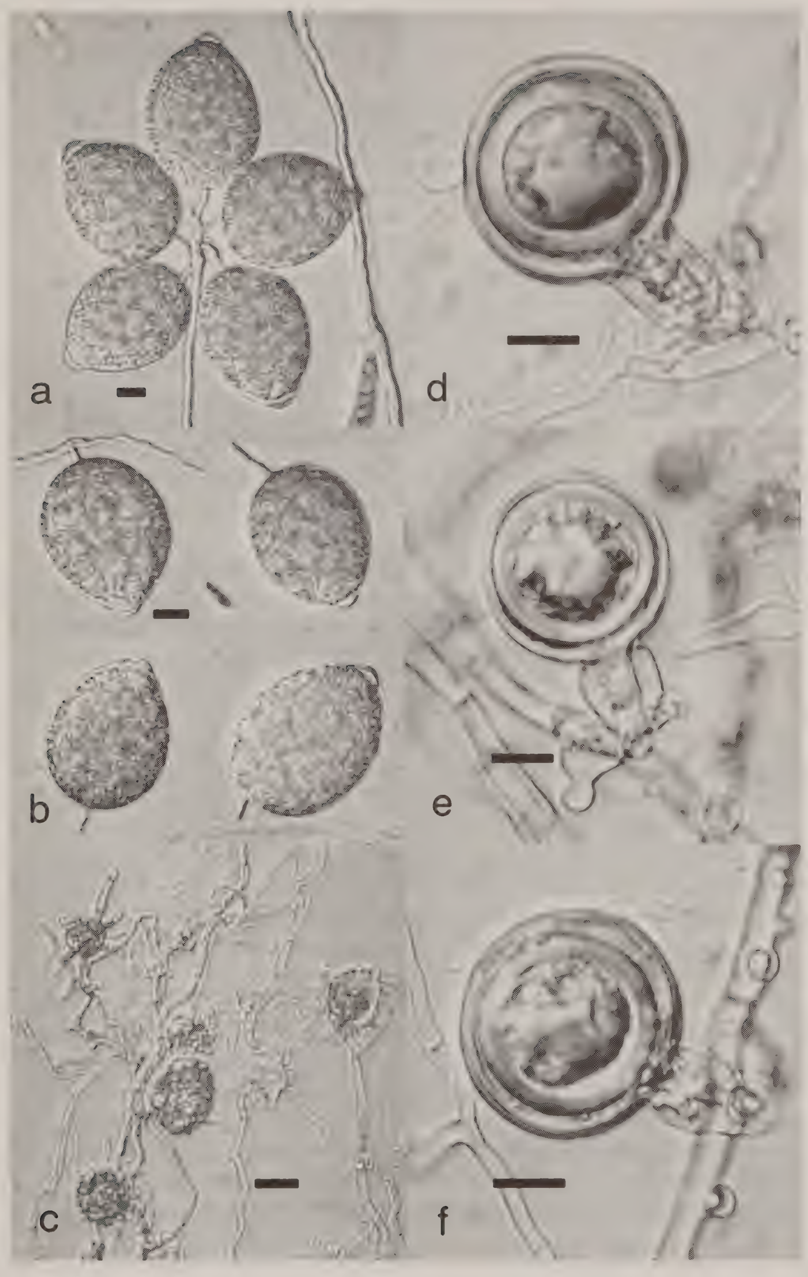
Isolate	Oogonium	Oospore	Antheridium
2052.1	32.5 +/- 2.4	29.7 +/- 2.7	12.5 +/- 2.2 x 13.0 +/- 0.8
2055.2	31.5 +/- 3.9	28.5 +/- 3.8	12.2 +/- 1.7 x 12.9 +/- 1.5
P7	34.1 +/- 5.2	29.1 +/- 4.9	14.4 +/- 1.5 x 13.4 +/- 1.1
P11	34.4 +/- 3.1	29.7 +/- 2.5	12.8 +/- 1.1 x 12.3 +/- 1.1
P-13 (type)	33.6 +/- 3.6	28.2 +/- 3.4	14.0 +/- 2.1 x 12.2 +/- 1.5

Table 2. Sporangial dimensions of five isolates of *Phytophthora nemorosa*, (microns, mean +/- SD, n=10)

Isolate	Length	Breadth	L:B Ratio	Pedicel	Apical plug
2052.1	56.3 +/- 4.4	44.6 +/- 4.4	1.3	7.4 +/- 1.6	9.7 +/- 1.3
2055.2	43.2 +/- 2.9	33.9 +/- 3.2	1.3	8.6 +/- 2.5	8.3 +/- 0.8
P7	50.5 +/- 6.2	37.2 +/- 7.6	1.3	10.3 +/- 6.1	9.0 +/- 1.4
P11	54.0 +/- 6.5	38.7 +/- 4.8	1.4	9.3 +/- 3.7	7.5 +/- 0.6
P-13 (type)	53.2 +/- 7.9	35.7 +/- 2.9	1.5	12.0 +/- 3.8	9.5 +/- 0.6

typically exhibit small, blistered hyphal swellings. Growth optimum is about 15C, with little or no growth above 20C. Sporangia formed in water are typically ovoid, scarcely semi-papillate, rarely bifurcate, appearing as terminal clusters on sympodially branched sporangiophores (Figure 1). Caducous sporangia average 51 µm in length (range 38 to 71 µm) and 37 µm in breadth (range 28 to 50 µm). L:B ratios range from 1.3 to 1.5 (average 1.4). Pedicel lengths average 10 µm (range <5-20µm), and apical plugs average 9 µm wide (Table 2).

Figure 1. *Phytophthora nemorosa.* a. sporangia formed in water, ovoid, semipapillate sporangia attached to sporangiophore showing close sympodia giving the appearance of terminal clusters, b. individual sporangia formed in water showing variable pedicel length, c. small hyphal swellings formed in CMAβ showing variable size and small blisters or finger-like projections, d., e., f., oogonia formed in CMAβ showing aplerotic oospores and amphigynous antheridia (Length of bar = 10µ.).


a
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Host range and distribution: *P. nemorosa* has been isolated most frequently from necrotic leaf tips of myrtlewood or California bay (*Umbellularia californica*). It has also been isolated from leaves of manzanita (*Arctostaphylos* species) and coast redwood (*Sequoia sempervirens*). It has been recovered from bark cankers on tanoak (*Lithocarpus densiflorus*) and

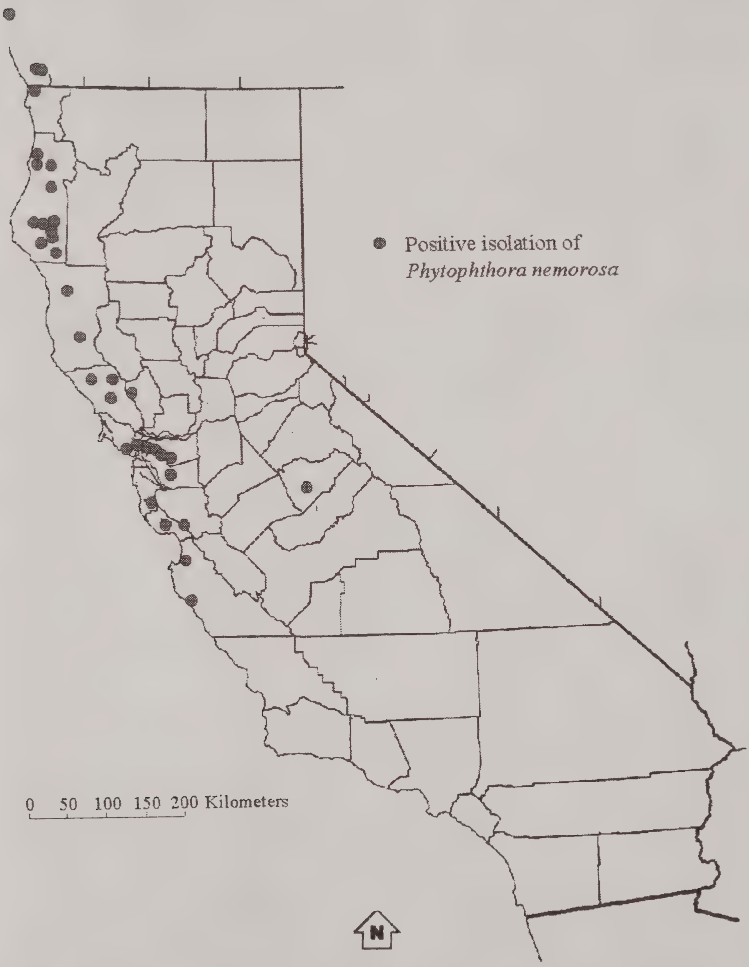
● Positive isolation of
Phytophthora nemorosa
0 50 100 150 200 Kilometers
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Figure 2. Geographic distribution of isolates of *P. nemorosa* from Oregon and California, U.S.A.

coast live oak (*Quercus agrifolia*) that are comparable in appearance to those caused by *P. ramorum*. Pathogenicity testing will be reported in a later paper, but work to date indicates that *P. nemorosa* is not pathogenic on English holly (*Ilex aquifolium*) as is *P. ilicis*, but does cause bark necrosis of tanoak in artificial inoculation (Davidson et al. 2002). *P. nemorosa* has been found in coastal counties from central California (Monterey Co.) to central Oregon (Coos Co.). It has also been isolated from one location in the Sierra Nevada Mountains (Figure 2).

Similar species: *P. nemorosa* and *P. ramorum* are remarkably similar in host range and symptomology. In culture, however, *P. nemorosa* grows more slowly, with a lower temperature optimum (15C) than *P. ramorum* (20C). Morphologically, *P. nemorosa* (homothallic and lacking chlamydospores), is readily distinguished from *P. ramorum* (Werres et al. 2001).

P. nemorosa falls in the artificial Group IV of Waterhouse (Waterhouse 1963, Erwin and Ribeiro 1996) based on gross morphology. Three species in this group are homothallic with amphigynous antheridia, and produce caducous, semipapillate sporangia. *P. ilicis* is most similar and is addressed below. *P. hibernalis* and *P. phaseoli* also share these features. The former is primarily a pathogen of citrus, and has longer sporangial pedicels (Erwin and Ribeiro 1996). The latter is mainly associated with lima bean and has smaller oogonia.

Phylogenetically, *P. nemorosa* falls in ITS DNA Clade 3 (Cooke et al. 2000), with *P. ilicis*, *P. psychrophila*, *P. pseudosyringae* (Jung et al. 2003), and *P. quercina* (Jung et al. 1999) (Figure 3). The latter two species have predominately paragynous antheridia. *P. nemorosa* is distinguished from *P. psychrophila* by its somewhat smaller oogonia (33 µm vs 37 µm), slightly rounder sporangia, and distinctly patterned colony growth on agar media where *P. psychrophila* grows without pattern. *P. ilicis* has smaller oogonia (27 µm) than *P. nemorosa*, and is known only from *Ilex* species.

DISCUSSION

Phytophthora nemorosa is a newly recognized Oomycete species that causes lethal bole cankers on tanoak and coast live oak and foliar necrosis on myrtlewood or California bay, and other hosts. It is found in areas where *Phytophthora ramorum* is also active and it has not been possible to distinguish the diseases caused by these pathogens in the field, although the two organisms are not easily confused in culture. In the forest *P. nemorosa* is usually associated with single killed trees and has behavior suggestive of an endemic pathogen, in contrast to the expanding patches of mortality associated with the exotic and invasive *P. ramorum*.

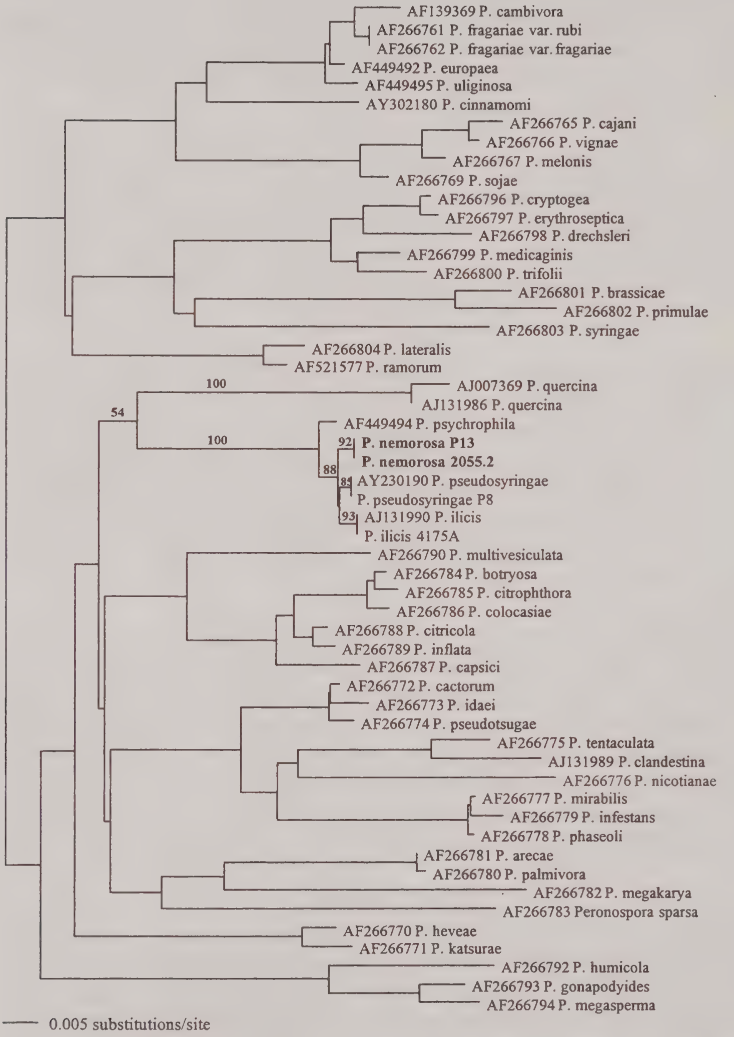
AF139369 P. cambivora
AF266761 P. fragariae var. rubi
AF266762 P. fragariae var. fragariae
AF449492 P. europaea
AF449495 P. uliginosa
AY302180 P. cinnamomi
AF266765 P. cajani
AF266766 P. vignae
AF266767 P. melonis
AF266769 P. sojae
AF266796 P. cryptogea
AF266797 P. erythroseptica
AF266798 P. drechsleri
AF266799 P. medicaginis
AF266800 P. trifolii
AF266801 P. brassicae
AF266802 P. primulae
AF266803 P. syringae
AF266804 P. lateralis
AF521577 P. ramorum
100
AJ007369 P. quercina
54
AJ131986 P. quercina
AF449494 P. psychrophila
100
92
P. nemorosa P13
P. nemorosa 2055.2
88
85
AY230190 P. pseudosyringae
P. pseudosyringae P8
93
AJ131990 P. ilicis
P. ilicis 4175A
AF266790 P. multivesiculata
AF266784 P. botryosa
AF266785 P. citrophthora
AF266786 P. colocasiae
AF266788 P. citricola
AF266789 P. inflata
AF266787 P. capsici
AF266772 P. cactorum
AF266773 P. idaei
AF266774 P. pseudotsugae
AF266775 P. tentaculata
AJ131989 P. clandestina
AF266776 P. nicotianae
AF266777 P. mirabilis
AF266779 P. infestans
AF266778 P. phaseoli
AF266781 P. arecae
AF266780 P. palmivora
AF266782 P. megakarya
AF266783 Peronospora sparsa
AF266770 P. heveae
AF266771 P. katsurae
AF266792 P. humicola
AF266793 P. gonapodyides
AF266794 P. megasperma
0.005 substitutions/site

Figure 3. ITS Phylogeny of *P. nemorosa* generated with PAUP* version 4.0b10 (Swofford 2000).

The ITS DNA sequence of *P. nemorosa* indicates close relationship to *P. ilicis* (a foliar pathogen of holly) (Figure 3), *P. psychrophila* (recently described from European oak forest soils; Jung et al. 2002), and *P. pseudosyringae* (Jung et al. 2003), and more distant relationship to *P. quercina*, all in ITS clade 3 (Cooke et al. 2000). The proliferation of newly recognized species in this clade is indicative of the taxonomic flux in the genus as a whole. This is in large part the result of increased attention to Phytophthoras in previously unexpected habitats, as well as to new molecular tools that aid diagnosis.

ACKNOWLEDGEMENTS

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LITERATURE CITED

Bonants, P. J. M., Hagenaar-de Weerdt, M., van Gent-Pelzer, M. P. E., Lacourt, I., Cooke, D. E. L. & Duncan, J. M. 1997. Detection and identification of *Phytophthora fragariae* Hickman by the polymerase chain reaction. *European Journal of Plant Pathology* 103: 345-355.

Buddenhagen, I.W. and Young, R.A. 1957. A leaf and twig disease of English holly caused by *Phytophthora ilicis* n. sp. *Phytopathology* 47: 95-101.

Cooke, D. E. L., Drenth, A., Duncan, J. M., Wagels, G. & Brasier, C. M. 2000. A molecular phylogeny of *Phytophthora* and related Oomycetes. *Fungal Genetics and Biology* 30:17-32.

Davidson, J. M., Garbellotto, M., Hansen, E. M., Reeser, P. & Rizzo, D. M. 2002. Another canker-causing *Phytophthora* from California and Oregon forest trees. *Phytopathology* 92: S17.

Erwin, D. C. & Ribeiro, O. K. (1996) Phytophthora Diseases Worldwide. American Phytopathological Society Press, St Paul, MN.

Hansen, E. M. 2000. *Phytophthora* in the Americas. In: *Proceedings of the 'First International Meeting on Phytophthora's in Forest and Wildland Ecosystems'* (E.M. Hansen & W. Sutton, eds) 30th Aug – 3rd Sept 1999, Grants Pass, Oregon: 23-27, Oregon State University, Corvallis, OR.

Hansen, E. M. and Delatour, C. 1999. *Phytophthora* species in oak forests of north-east France. *Annales des Sciences Forestières* 56 : 539-547

Jung, T., Cooke, D. E. L., Blaschke, H., Duncan, J. M. & Osswald, W. 1999. *Phytophthora quercina* sp. nov., causing root rot of European oaks. *Mycological Research* 103: 785-798.

Jung, T., Hansen, E. M., Winton, L., Oßwald, W. & Delatour C. 2002. Three new species of *Phytophthora* from European oak forests. *Mycological Research* 106: 397-411.

Jung, T., Nexhwatal, T., Cooke, D.E.L., Hartmann, G., Blaschke, M., Osswald, W. F., Duncan, J. M. and Delatour, C. 2003. *Phytophthora pseudosyringae* sp. nov., a new species causing root and collar rot of deciduous tree species in Europe. *Mycological Research* (In Press).

Kimura M. 1980. A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. J. Mol. Evol. 16:111-120.

Rizzo, D.M., Garbelotto, M, Davidson, J.M., Slaughter, G.W., and Koike, S.T. 2002. *Phytophthora ramorum* as the cause of extensive mortality of *Quercus* spp. and *Lithocarpus densiflorus* in California. *Plant Dis.* 86: 205-214

Swofford, D.L. 2000. PAUP: Phylogenetic analysis using parsimony and other methods, Version 4.0b2. Sinauer Associates, Sunderland, MA.

Waterhouse G. M. (1963) Key to the species of *Phytophthora* de Bary. *Mycological Papers* 92. Commonwealth Mycological Institute, Kew, U.K.

Werres, S., Marwitz, R., Man in't Veld, W. A, De Cock, A. W. A. M., Bonants, P. J. M., De Weerdt, M., Themann, K., Ilieva, E. & Baayen, R. P. (2001) *Phytophthora ramorum* sp. nov., a new pathogen on *Rhododendron* and *Viburnum. Mycological Research* 105: 1155-116.

White, T.J., Bruns, T., Lee, S., & Taylor, J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In *PCR Protocols: a guide to methods and applications* (M. A. Innis, D. H. Gelfand, J. J. Sninsky & T. J. White, eds): 315-322. Academic Press, San Diego.

MYCOTAXON

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A NEW SPECIES OF ACANTHOTHECIS FROM INDIA

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Keywords: **Lichens:** Graphidaceae, *Acanthothecis nivalis*, Andaman Islands

INTRODUCTION

The occurrence of spiny paraphyses tips and/or periphysoides in lichenized ascomycetes was known in only three species of *Acanthothecis* and one species of *Chroodiscus* until 1999. With the aim to get a more natural division of the family Graphidaceae in their studies on this family, Staiger and Kalb (1999) referred eighteen species to the genus *Acanthothecis* (Graphidaceae) including one species from the Andaman island, viz. *Acanthothecis incondita* (Nyl.) Staiger & Kalb [=*Graphina incondita* (Nyl.) Zahlbr.]. Recently, Staiger (2002) added six additional species to the genus.

During the course of our studies on the lichens of the Andaman islands of India, we discovered several interesting lichen taxa. One of them appeared to be a new species of *Acanthothecis,* described below as *Acanthothecis nivalis.*

MATERIALS AND METHODS

The specimens were examined with a stereomicroscope and a light microscope. Sections of the thalli and ascocarps were stained with Lugol's solution. All sections were examined with lactophenol as mounting medium. TLC was done by the standard method (Culberson & Kristinsson, 1970) using solvent systems benzene-dioxane-acetic acid (180:45:5) and hexane-ethylether-formic acid (130:80:20). All specimens were observed under UV light (365 nm).

TAXONOMIC DISCRIPTION

Acanthothecis nivalis Makhija & Adawadkar sp. nov. [Figs: 1-4]

Type: India, Andaman Islands, North Andaman, Mayabandar Range, Kaichi Nala, in moist deciduous forest, 30.12.1985, *M.B. Nagarkar & P.K. Sethy*, 85.2804 (Holotype-**AMH**).

Thallus corticolus, brunneolus, rimosus. Ascocarpia nivea, lirellata, ramosa, ±emergentia, gracilenta apicibus acutis. Excipulum non-carnonisatum, cristalis, incolor instructum. Paraphysis *ca.* 1 µm crassae, apicibus hyalinis et verrucosis. Paraphysoides *ca.* 24–32 µm longae, distincte verrucosae. Ascosporae octonae, hyalinae, fusiformae vel oblongae, cum 3–7 septis transversalibus, 8.4–16 x 3–4 µm, I-.

Similis *Acanthothecis consocians* sed imprimis differt ascocarpis distincte nivalis, et majoribus (2–8 mm long et 0.25 mm latis).

Thallus corticolous, brown, irregularly cracked, *ca.* 3–3.5 cm across, epruinose, delimited with a distinct black hypothalloidal region at the periphery, studded with numerous colourless crystals. **Ascocarps** white lirelline, raised above the thallus, simple to branched, slender, *ca.* 2–8 mm long and *ca.* 0.25 broad, with acute ends, disc not visible but when wet appears brown, very narrow, slit like. **Excipulum** uncarbonized, pale orange brown, entire to striate, convergent. **Hymenium:** *ca.* 58–63 µm high, clear. **Paraphysis** *ca.* 1 µm thick, tips hyaline, distinctly warty. **Periphysoids** emerging out of the inner side and the edge of the proper exciple covering the disc and continuing beneath the hymenium, distinctly warty, *ca.* 24–32 µm long. **Ascospores** 8/ascus, hyaline, transversely 4–7-septate, 8.4–16 x 3–4 µm, I-.
Chemistry: K-, C-, KC-, P+ yellow, UV-. Psoromic acid present.

Additional specimen examined: India, Andaman Island, Betapur Range, Pitcher Nala, in evergreen forest, P.G. Patwardhan & P.K. Sethy, 85.2372 (AMH).

Remarks: The new species *Acanthothecis nivalis* is easily distinguished from all other species of this genus by its pure white, effuse, raised lirellate, slender, simple to branched, 2–8 mm long and up to 0.25 mm broad ascocarps with non-carbonized exciple and transversely 3–7-septate ascospores.

The present species seems to be most closely related to *Acanthothecis consocians* (Nyl.) Staiger & Kalb, which has more or less similar morphology of the ascocarps and ascospores, but it differs from *A. consocians* in having much longer and branched, raised, white ascocarps with entire to striate excipulum and more or less smooth thallus without coarse grains.

The species has been found growing on tree trunks in moist deciduous forest of North Andaman and the evergreen forest of Middle Andaman, where the vegetation is typically a tropical one dominated by *Dipterocarpus* and rich in *Pleurocarpus* and *Mesua ferea*. The pyrenocarpous, graphidaceous and thelotremataceous lichens, which are corticolous in nature, predominate the lichen flora of these islands.

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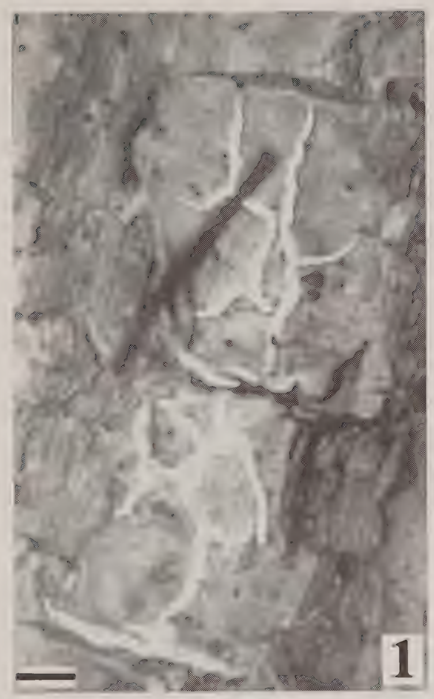
REFERENCES

Culberson, C.F. & Kristinsson, H. 1970. A standardized method for the identification of lichen products. *J. Chromatogr*. **46**: 85-93.

Staiger, B. 2000. Die Flechtenfamilie Graphidaceae Studien in Richtung einer natürlicheren Gliederung. *Biblioth. Lichenol.* **85**: 1-526.

Staiger, B. & Kalb, K. 1999. *Acanthothecis* and other Graphidioid lichens with warty periphysoids or paraphysis-tips. *Mycotaxon* **73:** 69-134.

Figs.: 1–4: *Acanthothecis nivalis* (Holotype – 85.2804) **1.** habit (bar = 1 mm); **2.** vertical section of the ascocarp (bar = 45 µm); **3.** ascospores & warty paraphysis-tips (bar = 10 µm); **4.** exciple with warty periphysoids-tips (bar = 10 µm).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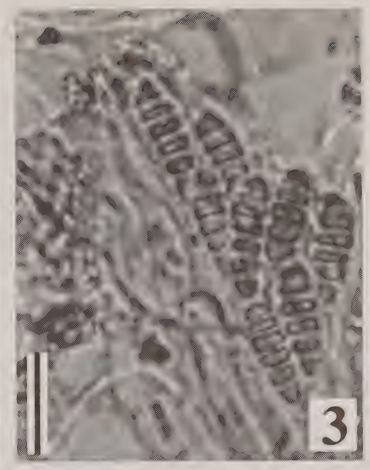
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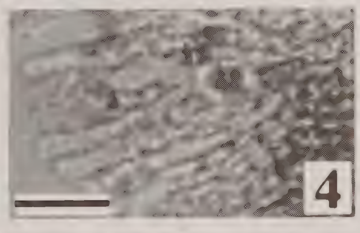
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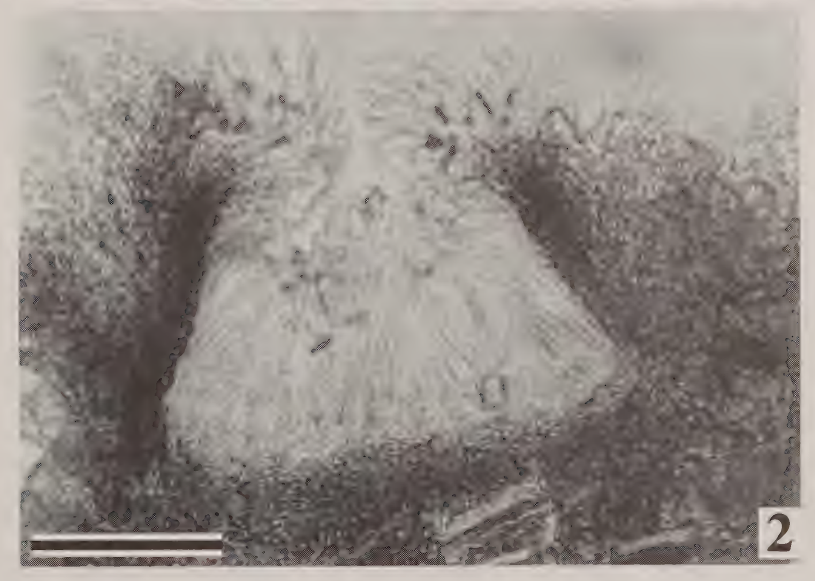
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NEW SPECIES IN THE LICHEN FAMILY GRAPHIDACEAE (ASCOMYCOTA) FROM AUSTRALIA AND THE SOLOMON ISLANDS

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ABSTRACT: *Graphina streimannii*, from Australia, and *G. asprocarpa, G. conferta, G. talisensis, Graphis castanocarpa* and *Phaeographina salazinica*, from the Solomon Islands, are described as new to science. Salazinic acid, present in *Phaeographina salazinica*, represents the first report of this compound in the genus *Phaeographina*.

KEY WORDS: *Graphina asprocarpa, Graphina streimannii, Graphina talisensis, Graphis castanocarpa, Phaeographina salazinica*

Australian species in the genus *Graphina* have recently been discussed (Archer 2001a) and new species in the Graphidaceae from the Solomon Islands have been described (Archer 2002). An examination of additional specimens from BM and CANB has shown the presence of six new species in the family Graphidaceae which are described here. Chemical constituents were identified by thin-layer chromatography (Culberson 1972) and where necessary their identity was confirmed by liquid chromatography (Elix et al. 2003).

1. **Graphina streimannii** A.W. Archer, *sp. nov.* Fig. 1

Similis *Graphina novae-zelandiae* (Knight) G. Hayward sed lirellis sessilibus, ascosporis minoribus et acidum psoromicum continens differt

Type: AUSTRALIA. Queensland: McIlwraith Range, 9 km NE of Coen, 13°53'S, 143°16'E, alt. 530 m, on shaded boulder, *H. Streimann 56842A*, 18.x.1995; holotype: CANB.

Thallus pale olive-green, thick, saxicolous, surface smooth and subnitid; *apothecia* lirelliform, inconspicuous, off-white, initially immersed, becoming sessile, straight, curved or sinuous, sometimes branched, 1-2.5 mm long, 0.25-0.4 mm wide, lips closed; *proper exciple* uncarbonised; *hymenium* 125-150 μm tall; *ascospores* 8 per ascus, uniseriate, ellipsoid, hyaline, 16-20 μm long, 9-11 μm wide, 4 x 2 locular, I+ pale blue.

Chemistry: psoromic acid (major) and atranorin (minor).

Graphina streimannii is characterised by the substrate preference, the sessile apothecia and the presence of psoromic acid, which was confirmed by liquid chromatography. The species resembles *G. novae-zelandiae* (Hayward 1977) but that species has immersed lirellae and lacks lichen compounds. The new species also resembles *G. psoromica* A.W. Archer but that species is corticolous and contains 2-methoxypsoromic acid (Archer 2001b).
The species is named after Heinar Streimann (1938-2001) who collected widely in Australia and elsewhere and made major contributions to Australian lichenology and bryology.

2. **Graphina asprocarpa** A.W. Archer, *sp. nov.* Fig. 2

Similis *Graphina erythrella* (Mont. & Bosch) Zahlbr. sed labiis pulverulentis vice laevibus et acidum norsticticum deficiens differt.

Type: SOLOMON ISLANDS. KOLOMBANGARA ISLAND; 2-4 miles [*ca.* 5 km] up Kolombangara River, on fallen log in river bed, *D.J. Hill 10416*, 31.viii.1965; holotype: BM.

Thallus pale fawn, corticolous, surface smooth and shiny; *apothecia* lirelliform white, conspicuous, numerous, scattered, flattened, subsessile, 1-4 mm long, 0.5-1.0 mm wide, curved or sinuous, irregularly branched, lips open, white pruinose; *proper exciple* uncarbonised; *hymenium*, 100-140 μm tall; disc coarsely white pruinose; *ascospores* elongate ellipsoid, hyaline, muriform, 8 per acus, (44-)52-60(-70) μm long, (10-)12-18 μm wide; I+ yellow.

Chemistry: no compounds found.

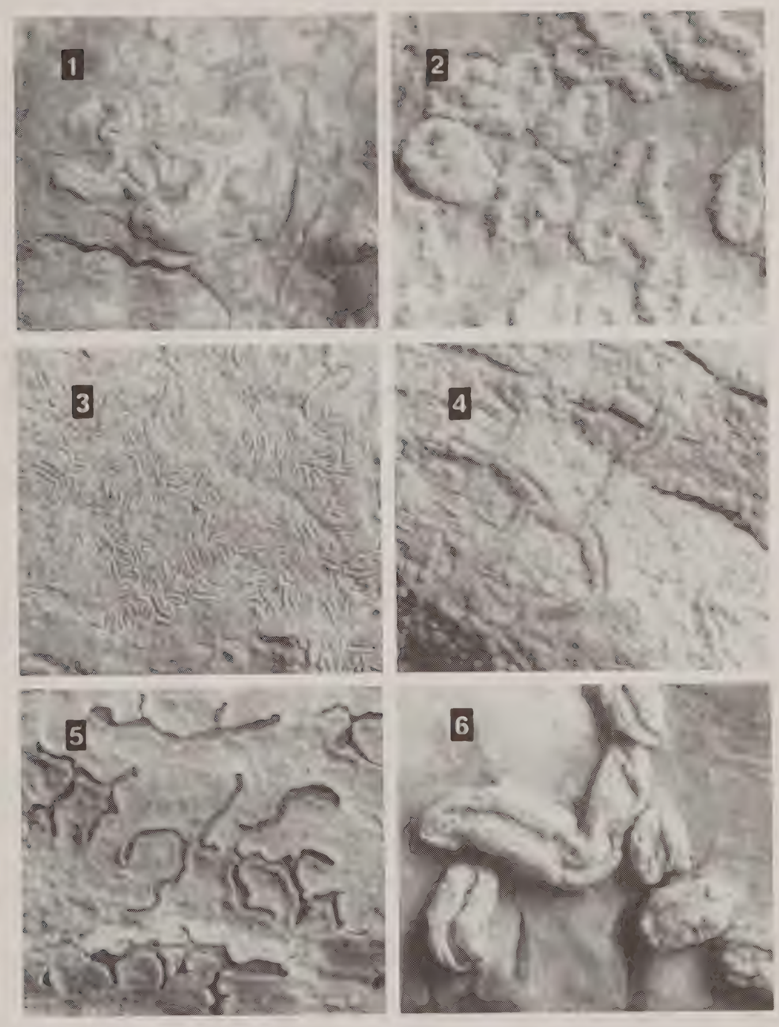
Graphina asprocarpa is characterised by the conspicuous white, open lirellae with white pruinose discs, the absence of a carbonised proper exciple and the absence of lichen compounds. It is distinguished from the somewhat similar *Graphina erythrella* by the absence of norstictic acid, present in *G. erythrella*. The species is so far known only from the type specimen.
The epithet *asprocarpa* is from *aspros*, whitish and *carpus*, fruit, a reference to the conspicuous white apothecia.

3. **Graphina conferta** A.W. Archer, *sp. nov.* Fig. 3

Similis *Graphina aggregans* (Nyl.) Zahlbr. sed lirellis brevioribus, angustoribus et confertioribus, et acidum sticticum continens vice acidum norsticticum differt.

Type: SOLOMON ISLANDS. KOLOMBANGARA ISLAND: 2miles [3.2 km] up Kolombangara River, *D.J. Hill 10210*, 23.viii.1965; holotype: BM.

Thallus pale greenish fawn, thin, corticolous, surface cracked, smooth and shiny; *apothecia* lirelliform, inconspicuous, numerous, immersed, clustered, lips initially closed becoming open, straight, curved or sinuous, often branched, 0.5-1.5 mm long, 0.5 mm wide; *proper exciple* uncarbonised; *hymenium* 80-100 μm tall



Figures 1-6. New species in the Graphidaceae from Australia
and the Solomon Islands (holotypes x 12)

Fig. 1: *Graphina streimannii*; Fig. 2: *Graphina asprocarpa*; Fig. 3: *Graphina conferta*;
Fig. 4: *Graphina talisensis*; Fig.5: *Graphis castanocarpa*;
Fig. 6: *Phaeographina salazinica*.

I+ weak blue; *disc* pale brown, epruinose; *ascospores* 8 per ascus, ellipsoid, 12-14 µm long, 6-7 µm wide, 4 x 2 locular, I+ blue.

Chemistry: stictic acid.

Graphina conferta is characterised by the numerous crowded lirellae, the absence of a carbonised proper exciple and the presence of stictic acid. It is distinguished from the somewhat similar *G. aggregans* by the smaller lirellae and the presence of stictic acid, in contrast to norstictic acid present in the latter. Mature ascospores are ellipsoid, 4 x 2 locular and react I+ blue, whereas immature ascospores are fusiform, 4 locular and react I+ yellow. The species is so far known only from the type specimen.
The epithet *conferta* is from the Latin *confertus*, crowded, a reference to the numerous, crowded lirellae.

4. **Graphina talisensis** A.W. Archer, *sp. nov.* Fig. 4

Similis *Graphina atrocelata* A.W. Archer sed excipulo carbonaceo deficiens et acidum sticticum continens differt.

Type: SOLOMON ISLANDS. SANTA ISABEL ISLAND: San Jorge Island, 1 mile [1.6 km] inland up river from Talise village (northeast coast of island), *D.J. Hill 10948*, 24.ix.1965; holotype: BM.

Thallus pale fawn, thin, corticolous, surface subtuberculate and dull; *apothecia* lirelliform, inconspicuous, concolorous with the thallus, scattered, curved or sinuous, sometimes branched, sessile, lips closed, sometimes becoming open, 0.2-0.4 mm wide, 1.5-3 mm long; *proper exciple* uncarbonised; *hymenium* 120-160 µm tall; *ascospores* ellipsoid, hyaline, muriform, (90-)100-136 µm long, 30-44 µm wide, I+ blue.

Chemistry: stictic acid.

Graphina talisensis is characterised by sessile lirellae which are concolorous with the thallus, an uncarbonised proper exciple and the presence of stictic acid. The species superficially resembles *G. atrocelata* A.W. Archer (Archer 2001a) but no carbonised exciple was present in *G. talisensis*, in contrast to *G. atrocelata* which has a laterally carbonised proper exciple. The ascospores are of a similar size in both species but *G. talisensis* contains stictic acid, in contrast to *G. atrocelata* which lacks lichen compounds.
The epithet *talisensis* is a reference to the type locality, Talise village, San Jorge Island.

5. **Graphis castanocarpa** A.W. Archer, *sp. nov.* Fig. 5

Similis *Graphis hypolepta* Nyl. sed ascosporiis majoribus differt.

Type: SOLOMON ISLANDS. KOLOMBANGARA ISLAND: 2 miles [3.2 km] up Kolombangara River, lowland rainforest, on *Pipterus argentens, D.J. Hill 10261*, 25.viii.1965; holotype: BM.

Thallus pale green, corticolous, surface smooth and dull; *apothecia* lirelliform, inconspicuous, numerous, scattered, immersed, initially fissurine, becoming open, curved or sinuous, sometimes branched, 0.5-1.5 mm long, 0.1-0.25 mm wide; *proper exciple* inconspicuous, uncarbonised; *disc* reddish brown, epruinose; *hymenium* 100-140 μm tall; *ascospores* 8 per ascus, elongate ellipsoid, hyaline, 68-75 μm long, 10-11 μm wide, 11-13 locular, I+ blue.

Chemistry: no compounds found.

Graphis castanocarpa is characterised by the immersed, open lirellae with a reddish brown disc, the absence of a carbonised proper exciple and of lichen compounds. The species is one of three morphologically similar species, i.e. with open, immersed lirellae with reddish brown discs, found in the Solomon Islands, which are differentiated by the size of the ascospores and chemistry, as shown in Table 1.

Graphis patula and *G. castanocarpa* are so far known only from the Solomon Islands whereas *G. hypolepta* also occurs in Colombia (Nylander 1863), Hawaii (Magnusson 1955) and Borneo (Krempelhuber 1875).

TABLE 1. *GRAPHIS* SPECIES FROM THE SOLOMON ISLANDS

SPECIES	ASCOSPORE SIZE	LOCULES	CHEMISTRY
G. hypolepta Nyl.	21-32 x 6-7 μm	8	nil
G. patula A.W. Archer	28-40 x 8-9 μm	9-11	stictic acid
G. castanocarpa A.W. Archer	68-75 x 10-11 μm	11-13	nil

Graphis castanocarpa is so far known only from the type specimen.

The epithet *castanocarpa* is from the Latin *castanea*, chestnut, a reference to the reddish brown lirellae.

6. **Phaeographina salazinica** A.W. Archer, *sp. nov.* Fig. 6

Similis *Phaeographina caesioradians* (Leight.) Redinger sed ascosporiis majoribus et acidum salazinicum continens differt.

Type: SOLOMON ISLANDS. SANTA ISABEL ISLAND: Tanabuli Island, near Tatamba, *D.J. Hill 11027*, 29.ix.1965; holotype: BM

Thallus dull green to pale fawn, thin, corticolous, surface smooth and shiny; *apothecia* lirelliform, conspicuous, scattered, initially immersed and closed, becoming sessile and open, off-white, straight, curved or sinuous, rarely branched, slightly sulcate, 1-6(-10) mm long, 0.6-1 mm wide; *proper exciple* inconspicuous, pale brown, complete; *disc* pale reddish brown, densely white pruinose; *hymenium* 200-250 μm tall; *ascospores* elongate ellipsoid, pale brown, muriform, 1 per ascus, (120-)150-180(-200) μm long, (26-)35-50 mm wide.

Chemistry: salazinic acid (major), consalazinic acid (trace), connorstictic acid (trace), subnorstictic acid, (trace), norstictic acid (trace), protocetraric acid (trace) and methyl norstictate (trace).

Also examined:

SOLOMON ISLANDS. KOLOMBANGARA ISLAND; ridge to west of Kolombangara River, alt. 300-600 m, *D.J. Hill 10764, 10774,* 8.ix.1965

SANTA ISABEL ISLAND; Tatamba, alt. 0-30 m, *D.J. Hill 11195, 11199,* 4.x.1965; *ibid.,* Tanabuli Island, near Tatamba, *D.J. Hill 11026,* 29.ix.1965.

Phaeographina salazinica is characterised by the conspicuous lirellae, the large, brown, muriform ascospores and the presence of salazinic acid. The new species superficially resembles *P. lamii* Redinger (Redinger 1936) but has less conspicuously sulcate lirellae, larger ascospores and contains salazinic acid. The presence of salazinic acid distinguishes the new species from all other species in the genus *Phaeographina.*

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LITERATURE CITED

Archer, A.W. (2001a).The lichen genus *Graphina* (Graphidaceae) in Australia: new reports and new species. *Mycotaxon* **77**: 153-180.
Archer, A.W. (2001b). New taxa and new reports in the lichen family Graphidaceae (Ascomycotina) from Australia. *Mycotaxon* **80:** 367-374.
Archer, A.W. (2002). Graphidaceae (Ascomycotina) from the Solomon Islands: new species from Guadalcanal. *Mycotaxon* **83:** 361-367.
Culberson, C.F. (1972). Improved conditions and new data for the identification of lichen products by a standardised thin-layer chromatographic method. *J. Chromatogr*. **72**: 113-125.
Elix, J.A., Giralt, M. & Wardlaw, J.H.. (2003). New chloro-depsides from the lichen *Dimelaena radiata*. Bibliotheca Lichenolologica 86: 1-7.
Hayward, G.C. (1977). Taxonomy of the lichen families Graphidaceae and Opegraphaceae in New Zealand. *N. Z. J. Bot.* **15**: 565-584
Krempelhuber, A. (1875). Lichens quos legit O. Beccari in insulis Borneo et Singapore annis 1866-1867. *Nuovo. Giorn. Bot. Ital.* **7**: 5-67.
Magnusson, A.H. (1955). A catalogue of the Hawaiian Lichens. *Ark. Bot.*, ser. 2, **3:** 223-402.
Nylander, W. (1863). Lichenes in Triana, J. & Planchon, J.E., Prodromos Florae Novo Granatensis. *Ann. Sci. Nat. Bot.*, sér. 4, **19**: 286-382.
Redinger, K.M. (1936). Die Graphideen der Sunda-Inseln. *Rev. Bryol. Lichénol.* **9**: 37-122.

MYCOTAXON

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NEW SPECIES AND RECORDS IN THE LICHEN FAMILY PARMELIACEAE (ASCOMYCOTA) FROM INDIA

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ABSTRACT: *Melanelia microglabra* and *Parmelia hygrophiloides* from India are described as new to science. Three additional species of Parmeliaceae are reported for the first time from India.

KEY WORDS: *Melanelia microglabra, Parmelia hygrophiloides, Allocetraria, Flavopunctelia*

The Himalayan region is renowned for the diversity of its lichen flora (Awasthi 2000; Divakar *et al.* 2001a, 2001b; Randlane *et al.* 2001; K. Singh 1999; K. Singh & Sinha 1994; Sinha 1999; Sinha & Elix 2003). In a continuation of the study of parmelioid lichens from this area we are describing a further new species from Himachal Pradesh and another from Sikkim, together with three new records of Parmeliaceae for India from these states. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Feige *et al.* 1993; Elix & Wardlaw 2002) and comparison with authentic samples.

Melanelia microglabra Divakar, Upreti, G.P. Sinha & Elix, sp. nov. Fig. 1

Thallus ut in *Melanelia pseudoglabra* sed saxicola, minoris, lobis angustioribus et acidum ovoicum et acidum 2-*O*-methyllecanoricum continente differt.

Type: INDIA. Sikkim: North Sikkim, Llonakh Valley, Muguthang, 4500 m, on rock, *G. P. Sinha 1570,* 1 Sept. 1999; holo: BSHC.

Thallus saxicolous, small-foliose, loosely adnate to adnate, coriaceous, to 1.5 cm wide. *Lobes* weakly imbricate, sublinear to irregular, 0.2-1.0 mm wide; margins eciliate, apices incised. *Upper surface* brown-black, flat or weakly convex, rugulose to warty; isidia, soredia, pseudocyphellae and pustules absent. *Medulla* white. *Lower surface* black, brown at the apices; rhizines sparse, simple, black. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex K-, HNO_3 + pale red; medulla K-, C+ pink, KC+ red, P-; containing gyrophoric acid (major), ovoic acid (submajor), lecanoric acid (minor), 2-*O*-methyllecanoric acid (minor).

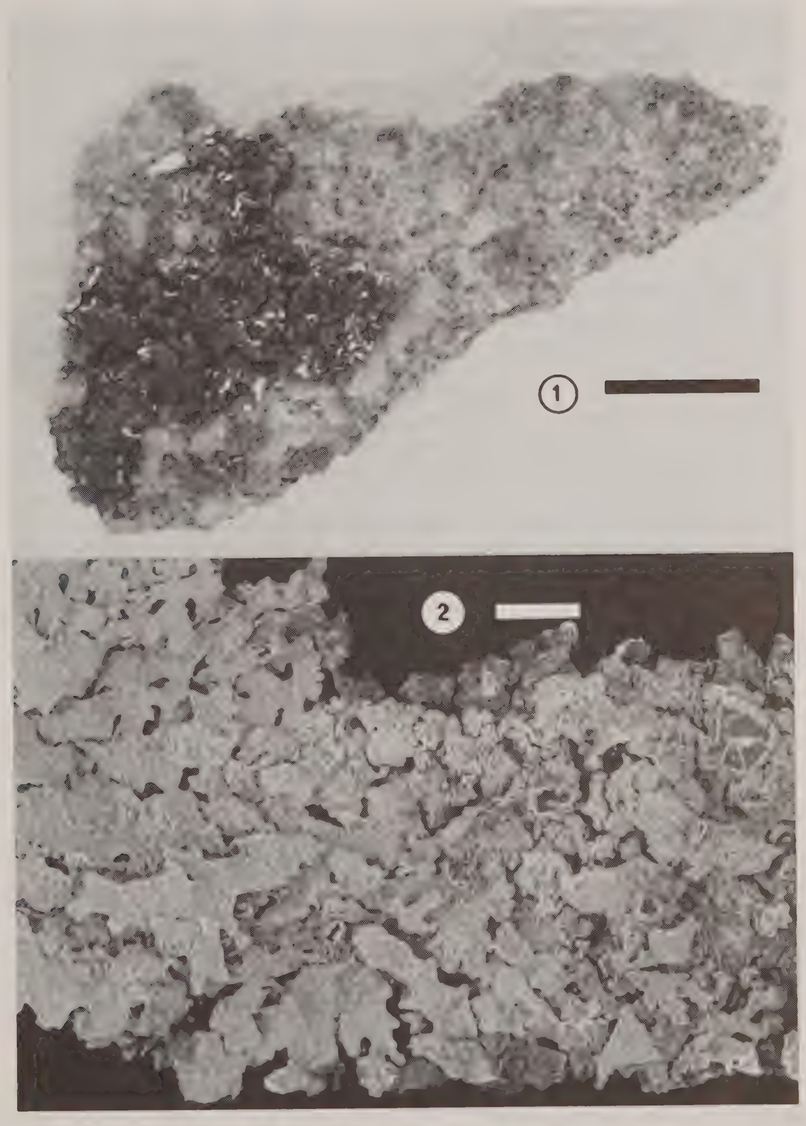
Melanelia microglabra resembles the Australian species *M. pseudoglabra* (Essl.) Essl. (Esslinger 1977); the two species have loosely adnate to adnate thalli which lack soredia and isidia, have a black lower surface and contain gyrophoric acid as the major medullary substance. However, *M. microglabra* can clearly be separated from *M. pseudoglabra* by the smaller thallus (0.5-1.5 cm cf. 2-4 cm wide), the narrower lobes (0.2-1.0 mm cf. 1-3 mm wide), the substrate preference (*M. pseudoglabra* is corticolous) and the medullary chemistry. *Melanelia pseudoglabra* contains gyrophoric acid (major), hiascic acid (minor), 5-*O*-acetyl-4-*O*-methylhiascic acid (minor), lecanoric acid (minor), 4-*O*-methylhiascic acid (minor) and ±2'-*O*-methylhiascic acid (Elix & Wardlaw 2001) whereas *M. microglabra* contains gyrophoric acid (major), ovoic acid (submajor), lecanoric acid (minor), 2-*O*-methyllecanoric acid (minor). In addition, *M. pseudoglabra* bears cortical hairs near the lobe apices and has small whitish pseudocyphellae visible on most lobes – both cortical hairs and pseudocyphellae are absent in *M. microglabra.* At present, the new species is known only from the type locality.

Parmelia hygrophiloides Divakar, Upreti & Elix, sp. nov. Fig. 2

Thallus ut in *Parmelia hygrophila* sed rhizinis densus, squarrosus ramosis et sporis minoribus differt.

Type: INDIA. Himachal Pradesh: Parbati River Valley, on way from Pulga to Bhandag Thaj, 2400 m, on *Pinus* trunk, *D. D. Awasthi & K. Dange 75.285,* 21 June 1975; holo: LWG-LWU.

Thallus corticolous, foliose, loosely adnate to adnate, to 9 cm wide. *Lobes* contiguous to weakly imbricate, sublinear to sublinear-elongate, ±divaricate, subdichotomously



Figures 1-2. New species of Parmeliaceae: 1. *Melanelia microglabra* (holotype in BSHC); 2. *Parmelia hygrophiloides* (holotype in LWG-LWU). Scale bar = 5.0 mm

branched, 2-6 mm wide; apices truncate. *Upper surface* grey, becoming grey-brown with age, flat or weakly concave, weakly ridged, ±weakly faveolate, shiny at the apices but dull within, maculae present particularly along ridges, developing into pseudocyphellae; pseudocyphellae laminal and marginal, scattered, not effigurate; laminal and marginal isidia present, initiated as intermittent clusters along marginal or laminal pseudocyphellae, isidia globose then short-cylindrical, becoming dense and forming a coralloid mass; apices of isidia epicorticate, becoming granular and sorediate, pale. *Medulla* white. *Lower surface* shiny, minutely wrinkled, black but dark brown at the margins; rhizines dense, simple to furcated, with dense, squarrose sub-branches, black. *Apothecia* sessile, 2-4 mm wide; disc concave at first then becoming flattened and developing stellate cracks, dark brown; exciple with sorediate-isidia. *Ascospores* ellipsoid, 10-15 x 6-8 µm. *Pycnidia* not seen.

Chemistry. Cortex K+ yellow-; medulla K+ yellow then dark red, C-, KC-, P+ orange; containing atranorin (minor), chloroatranorin (minor), salazinic acid (major), consalazinic acid (trace), methyl norstictate (trace), protocetraric acid (trace).

This species is characterized by the loosely adnate to adnate thallus with sublinear to sublinear-elongate lobes with scattered laminal and marginal pseudocyphellae which ultimately develop dense, ecorticate soredioid isidia, and the medullary salazinic acid. The presence of salazinic acid and soredioid isidia are reminiscent of *Parmelia hygrophila* Goward & Ahti from North America (Goward & Ahti 1983). However, in *Parmelia hygrophila* the rhizines are sparse, simple or apically furcate, ±rarely with a few lateral branches, whereas in *P. hygrophiloides* the rhizines are dense and sparsely furcate, but have dense squarrose subbranches. In addition, the ascospores of *P. hygrophiloides* are smaller than those of *P. hygrophila* (10-15 x 6-8 µm cf. 14-16 x 9-12 µm). *Parmelia hygrophiloides* could also be confused with *P. squarrosa* Hale since both are isidiate and have squarrose branched rhizines. However, the isidia of *P. squarrosa* differ in having brown-tipped, syncorticate (hard corticate) apices which do not become sorediate (Hale 1987). At present, the new species is known from several localities in the Indian State of Himachal Pradesh (western Himalayas).

Further specimens examined

INDIA. Himachal Pradesh: Parbati River Valley, above Pulga rest house, 2250-2340 m, on coniferous tree trunks, *D. D. Awasthi & K. Dange 75.138, 75.167, 75.173, 75.177, 75.179,* 21 June 1975 (LWG-LWU).

New Records of Parmeliaceae for India

Allocetraria denticulata (Hue) A.Thell & Randlane, in Daniels *et al.* (eds), *Flechten Follmann:* 359 (1995)

Allocetraria denticulata is distinguished by the yellow, dorsiventral upper surface, the pale brown lower surface, narrow (1.0-1.5 mm wide), apically indented lobes with marginal projections (these projections ±bearing pycnidia or small spines), the lack of pseudocyphellae and the presence of usnic acid in the cortex and lichesterinic, protolichesterinic and caperatic acids in the medulla. This species was previously known only from the type locality in Yunnan, China (Randlane *et al.* 2001; Thell *et al.* 1995).

Specimen Examined
INDIA. Sikkim: North Sikkim, north border side, Kupup, 4200 m, on bark, *G. P. Sinha 1497,* 19 Sept. 1998 (BSHC).

Allocetraria globulans (Nyl.) A.Thell & Randlane, in Daniels *et al.* (eds), *Flechten Follmann:* 360 (1995)

Allocetraria globulans is distinguished by the yellow upper surface, the pale brown lower surface, narrow (1.0-1.5 mm wide), slightly concave lobes which are not indented apically and the presence of usnic acid in the cortex and lichesterinic, protolichesterinic and ±secalonic acid A in the medulla. This species is known from Nepal and China (Randlane *et al.* 2001; Thell *et al.* 1995).

Specimen Examined
INDIA. Sikkim: North Sikkim, Llonakh Valley, between Muguthang and Naku La, 4500 m, on moss, *G. P. Sinha 1571B,* 1 Sept. 1999 (BSHC).

Flavopunctelia borrerioides Kurok., *Bull. Bot. Gard. Toyama* **4**: 26 (1999)

Flavopunctelia borrerioides resembles the much more common *F. flaventior* (Stirt.) Hale but is distinguished by the orbicular, laminal soralia rather than the mainly linear, marginal or more rarely capitate soralia of *F. flaventior.* Previously this species was only known from Mexico and Peru (Kurokawa 1999).

Specimens Examined
INDIA. Himachal Pradesh: Manali, 1800 m, on bark, *D. D. Awasthi s.n.,* 15 Oct. 1967 (LWG-LWU); Kullu District, near Banjar, 1700 m, on *Berchamia* shrub, *D. K. Upreti 21755218* (LWG).

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LITERATURE CITED

Awasthi, D. D. (2000). *Lichenology in Indian Subcontinent.* Printed by Gajendra Singh Gahlot, Shiva Offset Press for Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Culberson, C. F. (1972). Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* **72**: 113-125.

Culberson, C. F. & Johnson, A. (1982). Substitution of methyl *tert.*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. *Journal of Chromatography* **238**: 483-487.

Divakar, P. K., Upreti, D. K., Sinha, G. P. & Elix, J. A. (2001a). A new species of *Myelochroa* and new records in the lichen family Parmeliaceae (Ascomycotina) from Sikkim, India. *Mycotaxon* **79**: 247-251.

Divakar, P. K., Upreti, D. K. & Elix, J. A. (2001b). New species and new records in the lichen family Parmeliaceae (Ascomycotina) from India. *Mycotaxon* **80**: 355-362.

Elix, J. A. & Ernst-Russell, K. D. (1993). *A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances,* 2nd Edn. (Australian National University, Canberra).

Elix, J. A. & Wardlaw, J. H. (2001). 2'-*O*-Methylhiascic acid, a tridepside from the lichen *Melanelia pseudoglabra. Australasian Lichenology* **48**: 6-9.

Elix, J. A. & Wardlaw, J. H. (2002). 5-Chlorolecanoric acid, a new depside from *Punctelia* species. *Australasian Lichenology* **50**: 6-9.

Esslinger, T. L. (1977). A chemosystematic revision of the brown *Parmeliae. Journal of the Hattori Botanical Laboratory* **42**: 1-211.

Feige, G. B., Lumbsch, H. T., Huneck, S. & Elix, J. A. (1993). The identification of lichen substances by a standardized high-performance liquid chromatographic method. *Journal of Chromatography* **646**: 417-427.

Goward, T. & Ahti, T. (1983). *Parmelia hygrophila,* a new lichen species from the Pacific Northwest of North America. *Annales Botanici Fennici* **20**: 9-13.

Hale, M. E. (1987). A monograph of the lichen genus *Parmelia* Acharius sensu stricto (Ascomycotina: Parmeliaceae). *Smithsonian Contributions to Botany* **66**: 1-55.

Kurokawa, S. (1999). Notes on *Flavopunctelia* and *Punctelia* (Parmeliaceae) with descriptions of four new species. *Bulletin of the Botanic Gardens of Toyama* **4**: 25-32.

Randlane, T., Saag, A. & Obermayer, W. (2001). Cetrarioid lichens containing usnic acid from the Tibetan area. *Mycotaxon* **80**: 389-425.

Singh, K. P. (1999). Lichens of Eastern Himalayan Region. In *Biology of Lichens* (eds. K.G. Mukerji, B.P. Chamola, D.K. Upreti & R.K. Upadhayay) pp. 153-204. Aravali Books International, New Delhi.

Singh, K. P. & Sinha, G. P. (1994). *Lichen Flora of Nagaland.* Gajendra Singh Gahlot, Shiva Offset Press for Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

Sinha, G. P. (1999), Lichens of Sikkim. In *Biology of Lichens* (eds. K.G. Mukerji, B.P. Chamola, D.K. Upreti & R.K. Upadhayay) pp. 205-224. Aravali Books International, New Delhi.

Sinha, G. P. & Elix, J. A. (2003). A new species of *Hypogymnia* and a new record in the lichen family Parmeliaceae (Ascomycota) from Sikkim, India. *Mycotaxon* **87**: 81-85.

Thell, A., Randlane, T., Kärnefelt, I., Gao, X.-Q. & Saag, A. (1995). The lichen genus *Allocetraria* (Ascomycotina, Parmeliaceae). In *Flechten Follmann* (eds. F. J. A. Daniels, M. Schultz. & J. Peine), pp. 353-370. University of Cologne.

MYCOTAXON

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MATERIALS FOR A HYPOGEOUS MYCOFLORA OF THE GREAT BASIN AND ADJACENT CORDILLERAS OF THE WESTERN UNITED STATES. IX: A NEW NAME FOR PEZIZA QUERCICOLA FOGEL & STATES (ASCOMYCOTA, PEZIZALES)

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When proposing the name *Peziza quercicola* (Fogel & States 2002) we inadvertently created a later homonym of *P. quercicola* Sauter ex Winter. To correct this problem it is necessary to provide a new name.

Peziza infossa Fogel & States, *nom. nov.*
= *Peziza quercicola* Fogel & States, Mycotaxon 81: 78. 2002.
non Peziza quercicola Saut. ex Winter, Hedwigia 20:133.1881.

Etymology: infossus (L.), buried.
Latin description: Fogel & States Mycotaxon 81: 78. 2002.
Illustrations: figs. 4-6 in Fogel & States Mycotaxon 81: 78. 2002.

ACKNOWLEDGMENTS

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LITERATURE CITED

Fogel, R. and J. States. 2002. Materials for a hypogeous mycoflora of the Great Basin and adjacent cordilleras of the Western United States. VII: A new truffle-like *Peziza* (Ascomycota, Pezizales). Mycotaxon 81: 75-82.

Winter, G. 1881. Pezizae Sauterianae. Hedwigia 20:133.

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IGNEOCUMULUS YUCCAE, A FUNGUS WITH EVANESCENT ASCI AND A LECYTHOPHORA-LIKE ANAMORPH

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Abstract: *Igneocumulus yuccae* and its *Lecythophora*-like anamorph from cultures are described. The combination of soft, bright-colored, often apparently multilocular ascomata with one shared ostiole, prototunicate asci in a peripheral hymenium, the lack of hamathecial elements, aseptate, hyaline ascospores and the *Lecythophora*-like anamorph complicate determination of the relationships of this fungus.

Keywords: Hypocreales, loculoascomycetes, Sordariales

INTRODUCTION

During the survey of fungi from dead leaves of the Agavaceae, orange-red collections of spores were discovered on the epidermis of three *Yucca* species, *Y. brevifolia* Engelm., *Y. faxoniana* Sarg., and *Y. torreyi* Shafer. The immersed chambers beneath these collections contained hyaline propagules in a bright-colored, oily-appearing substance. The fungus was considered a coelomycete until the discovery of evanescing asci in younger spore-bearing structures. The ascomata are soft, bright-colored, lack paraphyses and pseudoparaphyses, and often are multilocular. The prototunicate, clavate, red-orange pigmented asci in a peripheral hymenium release ellipsoid to curved, aseptate, hyaline ascospores which collect in the venter with the colored ascus contents until release through the ostiole. Cultures from ascospores appear hyaline to salmon colored, never dematiaceous. This unusual combination of traits necessitates establishment of a new taxon, *Igneocumulus yuccae*.

MATERIALS AND METHODS

Ascomata sections were cut with a razor blade and mounted in tap water for measurement of asci, ascospores, and wall thickness using an ocular micrometer having 0.8 µm increments. Cultures were prepared for isolates 9225, 0201, and 0204 by suspending ascospores in a drop of sterile tap water on a Petri plate of potato dextrose agar (PDA, BBL), and spreading the drop with a sterile glass rod. Germinated ascospores were removed with a sterile needle and placed in tubes of PDA. Cultures were maintained on a tabletop in incident daylight (ID) at room temperature [RT (16–22 C)]. Growth rate was established by stabbing PDA in Petri plates with a needle charged with conidia from active cultures, sealing the plates with laboratory film, and incubation in ID at RT. Colony diam was measured daily with a mm scale.

TAXONOMY

Igneocumulus A.W. Ramaley gen. nov.

Ascomata perithecia, immersa, saepe multiloculis, ostiolo communi periphysibus; asci hymenio peripherali, clavati, evanescentes, contenta colorata; ascosporae ellipsoideae vel curvatae, aseptatae, laeves, hyalinae.

Ascomata perithecial, immersed, often multilocular with a common periphysate ostiole; asci in a peripheral hymenium, clavate, evanescent, contents pigmented; ascospores ellipsoid to curved, aseptate, smooth, hyaline.

Etymology: *Igneo;* fire colored + *cumulus;* heap, for the colored heaps of spores

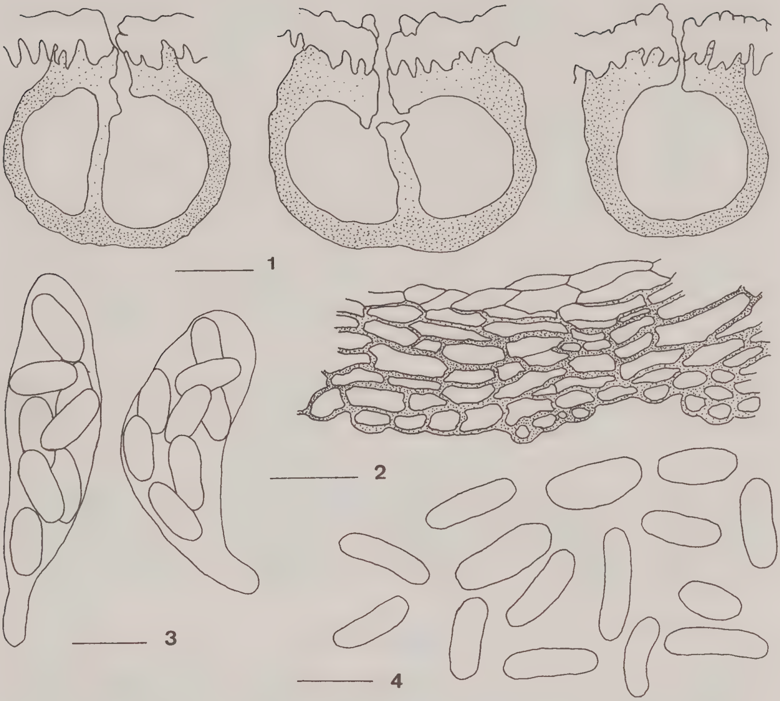
Igneocumulus yuccae A.W. Ramaley, sp. nov.

Ascomata perithecia, immersa, subepidermalia, 200–315 (–375) µm elata × 180–400 µm lata, sphaeroidea, interdum lobata, saepe multiloculis, papilla carens, loculi per ostiolum communem periphysibus tenuibus evacuati. Peridium 25–35 (–45) µm latum, molle, initio hyalinum, flavescens vel intense aurantiacens vel testacens, ex aliquot stratis cellularum coloratarum parietibus 1–2.5 µm crassis et aliquot stratis cellularum hyalinarum tenuiparietarum interdum admodum compressarum constans. Asci 24–42 (–52) µm, venter investientes praeter extremum supremum, clavati, prototunicati, evanescentes, (3–) 8-sporis, contento aurantiaceo, sine paraphysibus et pseudoparaphysibus. Ascosporae (4–) 5.6–8.8 (–11.2) µm, ellipsoideae vel curvatae, aseptatae, hyalinae, ventere acervulatae cum material aurantiaca oleosa-aspecta, liberatae per ostiolum.

Anamorph: *Lecythophora*-like

Holotype: U.S.A. TEXAS: Culberson Co., Guadalupe Mountains National Park, 3.6 miles from the highway gate on Williams Ranch Road, in dead leaves of *Yucca torreyi* Shafer, 23 Oct. 1995, Annette Ramaley #9539 (UC 1713843). Isotype, (BPI 842317). Cultures were deposited in CBS and ATCC.

Ascomata (Fig. 1) perithecia, immersed, subepidermal, 200–315 (–375) µm tall x 180–400 (–500) µm wide, sphaeroid, sometimes lobed, often with more than one locule, papilla lacking, locules emptying through a common ostiole at a stoma in the substrate epidermis, delicate periphyses present. Peridium (Fig. 2) 25–35 (–45) µm wide, soft, hyaline at first, becoming yellow to intense orange to brick red at maturity, the red-orange walls becoming yellow in 3% KOH, lactic acid, or lactophenol, consisting of several layers of pigmented



Figs. 1–4. *Igneocumulus yuccae*. 1. Ascomata. 2. Portion of bottom wall of an ascoma. 3. Asci. 4. Ascospores. Lines: Fig. 1 = 100 µm; 2 = 15 µm; 3, 4 = 6 µm.

cells, with walls 1–2.5 µm thick, and a few inner layers of thin-walled hyaline, sometimes quite compressed cells, cells near apex often pallid, composing several additional layers. *Asci* (Fig. 3) 24–42 (–52) x (4.8–) 6.4–12 µm, lining the venter except at the extreme upper end of a locule, clavate, prototunicate, evanescent as ascospores mature, (3–) 8-spored, with orange contents, paraphyses and pseudoparaphyses lacking. *Ascospores* (Fig. 4) (4–) 5.6–8.8 (–11.2) x (1.6–) 2.4–3.2 (–4.0), ellipsoid to curved, aseptate, hyaline, collecting in the venter with orange to orange-red, oily-appearing material from evanescing asci, released through the ostiole to the surface of the host forming a single orange-red or occasionally a pale orange droplet.

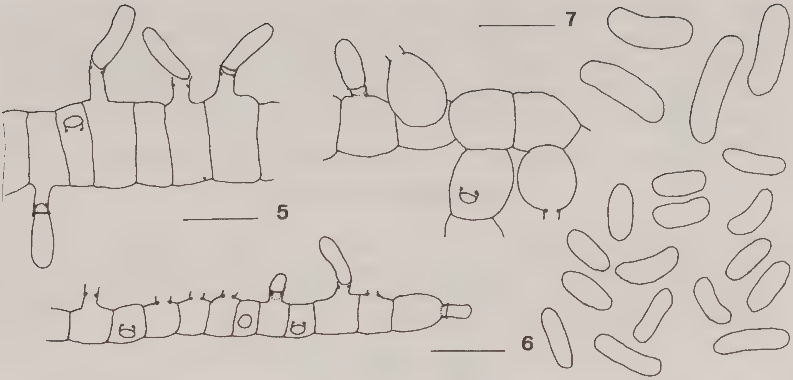
Paratypes: U.S.A. UTAH: Washington Co., north of St. George, U.S. Interstate 15, mile 18.1, in dead leaves of *Yucca brevifolia* Engelm., 2 June 1992, Annette Ramaley #9225 (BPI 842315). TEXAS: Culberson Co., Guadalupe Mountains National Park, ca 0.1 mi below Smith Springs, in dead leaves of *Yucca faxoniana* Sarg., 11 Oct. 2002, Annette Ramaley #0201 (BPI 842316).

TEXAS: Culberson Co., Guadalupe Mountains National Park, 5.5 mi from the highway gate on Williams Ranch Road, in dead leaves of *Yucca torreyi* Shafer, 12 Oct. 2002, Annette Ramaley #0204 (UC 1713842).

Anamorph in culture: Colonies from all isolates hyaline, becoming pale salmon by d 5. Hyphae appressed to the agar surface, 2.4–10 µm wide, no aerial hyphae present before colonies cover the plates, ca d 5, a few arising then, later collapsing into culture surface. Conidiogenesis phialidic; conidiogenous loci with periclinal thickening and collarette ca 0.5 µm tall, loci rarely terminating a hypha, usually on several adjacent procumbent hyphal cells, one locus per cell, loci (Fig. 5) directly on a hyphal cell, on a short, narrow peg extending from a hyphal cell, on an expanded outpocketing from a hyphal cell, or on an expanded outpocketing with a basal septum separating it from the hyphal cell. Conidia produced by 72 h, ellipsoid to curved, some nearly allantoid (Fig. 6) mostly 4–6 × 1.6–2 µm, but increasing in size after secession (Fig. 7), hyaline, smooth. Colonies slimy from accumulating conidia. After 2 months, colonies pale salmon, occasionally with spots of pale yellow or pink. There are some minor differences among cultures. The numerous successive conidiogenous cells were often wider than long in isolate 0204; isolate 9225 had fewer conidiogenous cells in an uninterrupted succession, many hyphal cells were doliform to rounded (Fig. 5), not cylindric, and conidia seemed relatively broader than in isolates 0201 or 0204; isolate 0201 grew more slowly averaging 52 mm diam after 6 d compared to 61 mm diam for isolates 9225 and 0204.

DISCUSSION

It has been impossible to place confidently this fungus systematically. In the loculoascomycetes the Tubeufiaceae, Pleosporales, are brightly colored but ascomata are superficial. Evanescent asci are present in a few families (Eriksson 1981) but, excepting the Coryneliaceae, their ascomata are cleistothecial. Loculoascomycete hyphomycetous anamorphs are usually dematiaceous with various sorts of conidiogenesis, while phialidic conidiogenesis is mostly restricted to coelomycetes (Seifert and Gams 2001). *Munkovalsaria rubra* Aptroot is exceptional in having seemingly compound ascomata with a single ostiole, similar to *Igneocumulus*, and a *Lecythophora*-like anamorph (Aptroot 1995). However, the broad pseudoparaphyses, and persistent, bitunicate asci are more typical of loculoascomycetes and adequate to distinguish the genus from *Igneocumulus*. *Valsaria insitiva* (Tode: Fr.) Ces. & De Not. is often pictured with separate ascomata in a valsoid configuration (Barr 1990, Dennis 1981, Müller & von Arx 1962), but Munk (1957) shows *Valsaria* cfr. *insitiva* ascomata appearing compound with a shared ostiole. In addition, stromata of some *Valsaria* species have vinaceous KOH-extractable pigments (Ju *et al* 1996). Treatment as a loculoascomycete with paraphyses, not pseudoparaphyses, by Munk (1957) and Ju *et al* (1996) may be supported by the production of coelomycetous and hyphomycetous synanamorphs in culture (Ju *et al* 1996). The hyphomycete resembles *Hormonema* Lagerberg & Melin, a genus associated with other loculoascomycete teleomorphs. However, *Valsaria* is also disposed in the hymenoascomycetes in the



Figs. 5–7. Anamorph of *Igneocumulus yuccae*. 5. Conidiogenesis in cultures. 6. Conidia. 7. Conidia that have enlarged after release from phialide. Lines: Fig. 5, 6, 7 = 6 µm.

Diaporthales (Kirk *et al* 2001) or the Xylariales (Barr 1990). The genus differs from *Igneocumulus*, for whether its asci are considered unitunicate or bitunicate, they are persistent, not evanescent, and *Valsaria* has brown, septate ascospores, and ascomata are immersed in an erumpent stroma.

The Hypocreales are characterized by soft, bright-colored ascomata with periphysate ostioles, the lack of apically free paraphyses or pseudoparaphyses and their non-dematiaceous anamorphs (Samuels & Blackwell 2001). This strongly suggests the order may be appropriate for placement of *Igneocumulus*. Although its possessing immersed habit, evanescent asci, and aseptate ascospores is not typical, these traits are distributed among species of *Nectriella*, Bionectriaceae (Rossman *et al.* 1999). It is troublesome, however, that the cultured *Igneocumulus* anamorph has the characteristics of *Lecythophora* Nannfeldt, a genus reintroduced (Gams & McGinnis 1983) to accommodate some hyphomycetes intermediate between *Phialophora* Medlar and *Acremonium* Link. Most *Lecythophora* conidia are formed on several adjacent cells of procumbent hyphae by phialides with periclinal thickening and collarettes, but not separated from the hyphal cell by a septum. *Lecythophora, Phialophora*-like anamorphs, and *Cladorrhinum* Saccardo and Marchal, a fungus with similar phialides, are not reported from the Hypocreales (Rossman *et al.* 1999) but from several families in the Sordariales (Barr 1990).

In the Sordariales, hyaline ascospores and deliquescent asci are exceptional, but present, along with *Phialophora*-like anamorphs, among species in the Lasiosphaeriaceae. However, most anamorphs of Sordariales are dematiaceous (Seifert and Gams 2001), ascomata are usually superficial or erumpent, ascomata that are not brown or black are pallid, asci are in basal fascicles or a basal hymenium, and ascospores are usually pale to deep brown or black and often have germ pores or germ slits (Barr 1990). All these traits differ from those of *Igneocumulus*.

The evanescent asci and unusual ascomatal structure of *Igneocumulus* provide no help in placing the genus systematically, and the *Lecythophora*-like anamorph is of little use for it is cited for both bitunicate and unitunicate ascomycetes. Molecular analysis might provide insight to relationships of the genus. Whatever alliances emerge, *Igneocumulus* is likely to be atypical or exceptional.

ACKNOWLEDGMENTS

I must thank the personnel at Guadalupe Mountains National Park for permission to collect within the park boundaries and for their encouragement in this project. It is my pleasure to thank Margaret Barr for reviewing this manuscript and for bringing *Munkovalsaria* to my attention.

LITERATURE CITED

Aptroot, A. 1995. Redisposition of Some Species Excluded from *Didymosphaeria* (Ascomycotina). Nova Hedwigia 60:325–379.
Barr, M.E. 1990. Prodromus to Nonlichenized, Pyrenomycetous Members of Class Hymenoascomycetes. Mycotaxon 39:43–184.
Dennis, R.W.G. 1981. British Ascomycetes. J. Cramer. Vaduz. 585 p.
Eriksson, O. 1981. The Families of Bitunicate Ascomycetes. Opera Bot. 60:1–220.
Gams, W., and McGinnis, M.R. 1983. *Phialemonium*, a New Anamorph Genus Intermediate Between *Phialophora* and *Acremonium*. Mycologia 75:977–987.
Ju, Y-M., J.D. Rogers, and S.M. Huhndorf. 1996. *Valsaria,* and notes on *Endoxylina, Pseudothyridaria, Pseudovalsaria,* and *Rouseoella.* Mycotaxon 58:419–481.
Kirk, P.M., P.F. Cannon, J.C. David, and J.A. Stalpers. 2001. Dictionary of the Fungi. CAB International, Wallingford, UK. 655 p.
Müller, E. and J.A. von Arx. 1962. Die Gattungen der didymosporen Pyrenomyceten. Beitr. Kryptogamenfl. Schweiz 11(2):1–922.
Munk, A. 1957. Danish Pyrenomycetes. Dansk Botanisk Arkiv 17(1):1–491.
Rossman, A.Y., G.J. Samuels, C.T. Rogerson, and R. Lowen. 1999. Genera of Bionectriaceae, Hypocreaceae, and Nectriaceae (Hypocreales, Ascomycetes). Stud. Mycol. 42:1–248.
Samuels, G.J. and M. Blackwell. 2001. Pyrenomycetes—Fungi With Perithecia. In: McLaughlin, D.J., E.G. McLaughlin, and P.A. Lemke, editors. The Mycota VII Part A, Systematics and Evolution, Springer-Verlag, Berlin Heidelberg. 221–256.
Seifert, K.A. and W. Gams. 2001. The Taxonomy of Anamorphic Fungi. In: McLaughlin, D.J., E.G. McLaughlin, and P.A. Lemke, editors. The Mycota VII Part A, Systematics and Evolution, Springer- Verlag, Berlin Heidelberg. 307–347.

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ALTERNARIA THEMES AND VARIATIONS (310–335) SPECIES ON MALVACEAE

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ABSTRACT

A continuation of a series of papers primarily on *Alternaria,* in this instance for phaeodictyosporic taxa described from hosts/substrates in the Malvaceae. Of the approximately 41 names published validly or invalidly for this group (1838 to date), 13 are retained for identifiable taxa in *Alternaria* and *Stemphylium.* Of these, 4 presented as spp. nov. are *A. anodae* on *Anoda cristata; A. hibiscinficiens* on *Hibiscus sabdariffa; A. malvacearum* on *Abutilon theophrasti; A. sidae* on *Sida fallax;* and 5 as comb. nov. are *A. hibiscina* on *Abelmoschus esculentus; A. malvae-vulgaris* on *Malva vulgaris; A. spadicea* on *Abelmoschus esculentus; S. gossypicola* on *Gossypium herbaceum;* and *S. nigricans* on *Gossypium herbaceum.*

Keywords: *Macrosporium, Stemphylium, Thyrospora, Abelmoschus, Abutilon, Anoda, Gossypium, Hibiscus, Malva, Sida, Solanum*

XXXI. SPECIES OF ALTERNARIA ON MALVACEAE

with disposition of some names of non-*Alternaria*
phaeodictyosporic hyphomycetous taxa
described from the same host family

INTRODUCTION

At least 41 names with actual or potential *Alternaria* or *Stemphylium* affinity have been published for taxa described from hosts or substrates in the

Malvaceae in the period 1838 to the present. Only a few of the species have a documented history of phytopathological interest, the most notable being *A. macrospora* A. Zimmermann on *Gossypium*. Another on the field pest *Anoda cristata* may have interest as a biocontrol agent in subtropical fields; it is treated here as a previously undescribed species (*Alt.T&V* 333).

It should not be deduced from this paper that I consider it to be more than a baseline for the taxonomy of *Alternaria* taxa on Malvaceae. The genera *Gossypium*, *Hibiscus*, and *Abelmoschus* are of economic value, and most of the taxa discussed here are from these substrates. However, the USDA *Fungi on Plants and Plant Products in the United States* (Farr et al., 1989) has entries for only six named *Alternaria* taxa for the few species of Malvaceae listed for the country, whereas Willis (1973) notes 75 genera and 1000 species for the family throughout temperate and tropic regions. There are more malvacicolous *Alternaria* taxa out there—an opinion based on the numbers of interesting herbarium specimens from diverse regions that I have decided not to discuss here because of scanty material or lack of cultures, the latter being essential.

Each named taxon of the subject group is given an entry below, in chronological order of publication of its basionym. Synonyms are discussed out of order under accepted/correct names. Typification elements are designated. References to treatments of individual taxa in papers of this series are in the format *Alt.T&V* xxx, which can be located under Simmons entries in *Literature Cited*. Each specimen or culture discussed in the text has a record number in the format EGS xx-xxx; the provenance of each such item is detailed in an *Appendix*. Culture collection acronyms cited in **BOLD** are those in general use, as are those of herbaria (Holmgren et al., 1990).

The usual problem of comparing and discussing both static field specimens and isolates developing in culture is encountered. When possible, patterns of growth and septation of conidia through juvenile to mature stages are used in making identifications. Comparison of cultures under controlled conditions and direct examination of colonies at 40X as well as at higher magnifications have been routine. Culture conditions are standard for all of these *Alt.T&V* studies: inoculated PCA, V-8, and Hay-decoction agars in separate sections of each Y-plate, maintained at moderate temperatures (ca. 22C), without humidity control (a gradually drying atmosphere in unsealed plates), under a fluorescent light/dark cycle of 8/16 hrs. (Simmons 1995b). In this current paper, all illustrations of living material are from cultures grown on V-8-juice agar.

310. **Mystrosporium stemphylium** Corda (1838), Icones Fungorum II, p. 13. Tab. X, fig. 61.

Lectotype (designated here): Corda's cited illustration (ICBN Art. 8.1, 9.9; Greuter et al., 2000). A typifying specimen "*auf Stengeln und Blättern der Georginen* [*Dahlia* sp.] *und Malven* [*Malva* sp.]" has not been found among Corda's specimens at [**PR**]. This remains a *species incertae sedis*.

Corda's name represents the earliest material described from a malvaceous substrate that might be an *Alternaria*. However, as has been remarked elsewhere (Simmons 1995a), no pertinent Corda specimen has been located. The lectotype illustration may represent a taxon of any one of several genera maintained today, including *Alternaria* and *Ulocladium*. A convincing opinion on the identity of the taxon is impossible unless authentic material can be found.

311. **Alternaria tenuis** Nees f. **malvarum** Rabenhorst (1844), Deutschlands Kryptogamen-Flora, vol. I, Pilze, p. 39.

Lectotype (designated here): illustration, Krombholz, Naturgetreue Abbildungen und Beschreibungen . . . Erstes Heft. 1831; Taf. 6, fig 27, 27a, and p. 84 (Erklärung der . . . Tafeln), which is Rabenhorst's cited basis for his forma "*malvarum.*" No type specimen has been located.

Krombholz discussed a white variant (*Abart*) of his concept of the olive-green basic species (*Stammart*) *Alternaria tenuis* Nees. His illustration of chains of several long-narrow-elliptical elements alternating with delicate filaments (*zarte Wechselfaser*) has the appearance of what commonly would be drawn as a habit sketch of a member of the *A. tenuissima* group of species. Krombholz (l.c., p. 79) discussed material on leaf petioles of *Malva alcea* L.

Rabenhorst added nothing to the characterization of the taxon but listed two malvaceous substrates for his *A. tenuis f. malvarum, Malva alcea* and *Althaea officinalis* L. Oudemans (1923) introduced an inclusive variant name, "*A. tenuis f. malvacearum* Rab.," which, however, is superfluous and therefore illegitimate (ICBN Art. 52). The fungus named *A. tenuis f. malvarum* is unidentifiable on the basis of available information.

312. **Stemphylium cordae** Fries (1849), Summa Veget. Scand. p. 506.

The type of *S. cordae* Fries is Corda's illustration of *Mystrosporium stemphylium* Corda, as lectotypified above in *Alt.T&V* 310. Fries's entire entry for this name reads (ital. sic): "Stemphylium. *Wallr*.. . . 2. S. Cordae. Fr. 1. Mystrosp. *Cord. I. f. 61.*" (in error for Corda, l.c., II. f. 61). Fries's introduction of *S. cordae* presumably was to avoid a tautonym, which would be invalid, both in his practice and in that of ICBN Art. 23.4. The taxon is unrecognizable under either name on the basis of available information.

313. **Alternaria gossypina** (Thümen) J.C.F. Hopkins (1931), Trans. Brit. Mycol. Soc. 16: 136. Fig. 224

≡ *Macrosporium gossypinum* Thümen (1877), Herb. Mycol. Oeconom. n. 513. Lectotype (designated here) **[BPI]**: *Nord-Amerika: Aiken in Süd-Carolina auf abgestorbenen Stengeln der cultivirten Baumwolle, Gossypium herbaceum Walk. et Arn. Selten. Herbst 1876. leg. H. W. Ravenel*; (EGS 07-003).

Sporulation elements in the type of *A. gossypina* occur as unremarkable scant growth on the surface of old hard stalks of cotton plants. The conidia themselves, although not strikingly unusual for small-spored *Alternaria*, can be described sufficiently well for comparison with other material from similar sources.

The conidium shape is basically a beakless ovoid with l/w 2.0-2.2 when it reaches a common size of ca. 35-40 x 17-20μm. A short 1-3-celled apical secondary conidiophore sometimes is produced, indicating chain formation; or the apical cell may generate a simple, short, upward-narrowing extension, which, experience suggests, characterizes the terminal spore of a period of chain formation in nature. The occasional elongate conidium (l/w ca. 3.0) is a variant of the basic shape; it illustrates a pattern found in populations of many *Alternaria* taxa—relatively short conidia of a population commonly increasing in width whereas a chain neighbor may sacrifice width for increase in length.

Conidia with at least some longitudinal septa are 27-50(-55) x 13-21μm and have up to seven transverse septa plus 0-2 longitudinal septa in each transverse segment. The intraconidial pattern of cell development in the type conidia is mostly distoseptate, with a euseptum present and slightly constricting only at the transverse median. Only a few of the largest conidia are euseptate and constricted at three major transepta. The conidium outer wall appears practically smooth in conserved herbarium material.

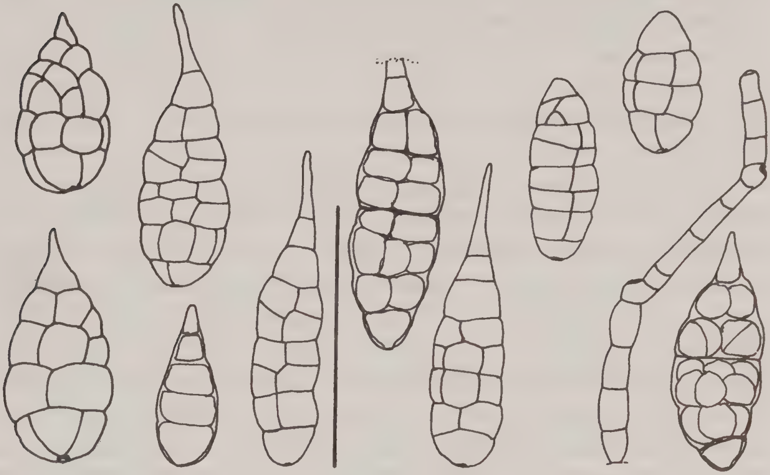

Fig. 224. *Alternaria gossypina*: conidia and conidiophore ex lectotype **BPI**; Thümen, *Herb. mycol. oeconom. 513* (EGS 07-003). Bar = 50μm.

The precise characterization of *A. gossypina* morphology is not important to an understanding of the nature of an *Alternaria/Gossypium* pathology. Certainly *Alternaria* leaf spot and boll rot of cotton are common and destructive conditions; however, information about the type specimen is useful primarily in revealing that most, perhaps all collections vouchered as *A. gossypina* in herbarium holdings that I have examined are misidentified. On examination of 60+ collections labeled as *A. gossypina* or *Alternaria* sp. on cotton leaf lesions, I am at a loss to find a conserved specimen of *Alternaria* on a *Gossypium* substrate that matches the type of *A. gossypina* closely enough to be identified with it. It appears to have been convenient to use the name for any small-spored *Alternaria* found on *Gossypium*—but, as in the use of the name *A. citri* for nearly every *Alternaria* from every conceivable tissue of citrus (see *Alt.T&V* 28, Simmons 1990), the name *A. gossypina* has been misused with abandon.

Part of the identification problem resides in the fact that the type of *Macrosporium gossypinum* was described from dematiaceous growth on dead, brittle stalks of cotton collected by Ravenel in the autumn season of South Carolina. Field stalks, fractured and weathered in a warm climate after boll harvest in September and October, can scarcely be considered substrates comparable to small lesions on living leaves or to boll fibers. Essentially all herbarium and field material that has been available to me is of leaf lesions; leaf spot and cotton boll rot are the diseases commonly attributed and, as far as examination of many herbarium specimens is concerned, misattributed to *A. gossypina*.

Thümen described *M. gossypinum* and distributed type material as no. 513 of his *Herbarium Mycologicum Oeconomicum*, selecting it from what must have been an abundant gathering of stalks. This set of exsiccati is rarely encountered; Stevenson (1971) records accessions at only three institutions in the U.S.A. The copy of no. 513 at **BPI** is in good condition and supports the description, illustration, and observations given above. Thümen also issued portions of Ravenel's type gathering as no. 1469 in his widely available *Mycotheca Universalis* (1879a). Although he characterized the taxon as rare or scarce on the meager portions he packeted, the Ravenel collection was large enough to accommodate an edition of *Mycotheca universalis* that is to be found in at least 25 sets (some partial) among herbaria in North America alone (Stevenson 1971). The possibility that each distributed portion actually bears *A. gossypina*, and not another *Alternaria* taxon also or instead—or even none—merits investigation and discussion. (And see Simmons 2000, p. 21, "An Aside on Lectotypes from Divided Collections.")

For the type gathering itself, a portion in Thümen's *Herb. Mycol. Oecon*. no. 513 (**BPI**, EGS 07-003) establishes the basic identity of *A. gossypina*. Of the later distributions in Thümen's *Mycol.Univ*. no. 1469, I have examined three examples: one at **NY** (EGS 03-055) contains *A. gossypina*; another at **NY** (EGS 03-123) contains *A. gossypina* with a minor intermixture of an *Alternaria* somewhat similar to *A. mouchaccae* (see *Alt.T&V* 2, Simmons 1981); and a portion at **BPI** (EGS 51-049) holds a dominant growth of a *Ulocladium* species, plus some strongly ornamented distoseptate conidia of *A. cfr. macrospora*, and a minor immixture of *A. gossypina* conidia.

As to herbarium accessions of field collections of cotton leaf lesions labelled *A. gossypina* or simply *Alternaria* sp. (I have examined mostly **BPI, IMI, NY**), the range of taxon differences broadens to include large filament-beaked conidia of *A. macrospora*; elongate, median-constricted conidia of the *A. tenuissima* species-group; distinctive eccentric-beaked conidia of a *Stemphylium* (see *Alt.T&V* 322 below); a relatively small-spored *Alternaria* with long filamentous beaks; another large-spored *Alternaria* whose long filamentous beak sometimes is branched (a character not seen in *A. macrospora*); and several representatives of small-spored *Alternaria* taxa that cannot be characterized more precisely than that they are not *A. gossypina*.

The bottom line, of course, is that "*Alternaria* leaf spot of cotton" does not have a taxon-specific etiology as far as small-spored species of *Alternaria* are concerned. (Large-spored *A. macropora* is another matter.) The purported "*A. gossypina*" relationship to cotton is roughly analogous to that of a reported "*A. citri*" or "*A. alternata*" relationship to "*Alternaria* brown spot" of mandarin oranges—a citrus pathology that actually is associated worldwide with numerous different species of *Alternaria* (*Alt.T&V* 226-235; Simmons 1999).

314. **Alternaria hibiscina** (Thümen) E. G. Simmons, comb. nov. Fig. 225

≡ *Macrosporium hibiscinum* Thümen (1878), Mycotheca Universalis no.979. Lectotype (designated here) [**BPI** 445324]: *America septentr.: Aiken-Carolina australis - ad Hibisci esculenti Lin. caules emortuos 1877. (no. 2247). Leg. H. W. Ravenel*; (EGS 49-107).

As with *Alternaria gossypina (Alt.T&V* 313, above), Ravenel contributed sufficient material of dead okra stems (*Abelmoschus (Hibiscus) esculentus* (L.) Moench) that Thümen could apportion it (meagerly) among his widely distributed set of exsiccati, *Mycotheca universalis*. Two portions at **BPI**—one of the exsiccatus, the other a remainder "ex herb. de Thuemen"—yield excellent sporulation elements of the taxon, which developed as black, effuse patches on the substrate. The taxon is not known to have been isolated in culture; its name in *Macrosporium* has rarely been used on a conserved specimen other than the type gathering. However, the morphological development of its conidia in nature presents characteristics that may support an *Alternaria* species-group concept if this and similar taxa ever are collected and cultured.

Conidia of *A. hibiscina* become broadly ovoid as soon as secondary longitudinal and oblique septa are inserted between major transepta. The conidium base is broadly rounded; the apical few cells narrow into a sturdy, bluntly rounded beak region, sometimes to an extent that renders the conidium shape obclavate. Chain formation occurs by means of an apical secondary conidiophore only 1-2 cells long. Chain production in the type is uncommon, with most of the conidia retaining a broad, blunt-end aspect with a well-developed network of eusepta. Conidia often show a minor amount of asymmetry, enlarge to a range of 50-75 x 18-28μm, and have up to 8-9 transepta (4-5 constricting) and 3-5 longitudinal or oblique septa in the largest transverse segments. Walls are smooth and dilute tan with a darker basal hilum region.

Because I am maintaining that *A. hibiscina* is a distinguishable taxon in the genus, Thümen's type description must be interpreted in order to avoid potential dissent from my observations on the lectotype. He wrote (transl.): Spores long-clavate, 8-14 septate . . . apex rounded, base a long, narrowed pedicel . . . 60-80 x 16-20μm (including the pedicel). His comments, after correcting the orientation of the conidium in relation to the conidiophore, should read: spores long-obclavate (but only if the apex has produced extra cells leading to formation of a secondary conidiophore); 8-9 transepta, up to 14 only when septa in a secondary conidiophore are counted; gradually narrowing into a 1-cell rounded apex; base broadly rounded; 60-80 x 16-20(-29)μm. I think that he and I have characterized the same taxon.

315. **Alternaria abutilonis** (Passerini) C. A. Schwarze (1917), N. J. Agr. Exp. Sta. Bull. 313, p.126. Fig. 226

≡ *Macrosporium abutilonis* Passerini (1879), in Spegazzini, Decades Mycologicae Italicae no. 58. Lectotype (designated here) [**BPI** 445014]: *Ad folia languida Abutilonis Avicennae Parma in R. Horto Botanico. Aug. 1878. Leg. Dr. G. Passerini*; (EGS 07-101; 49-113).

≡ "*Macrosporium abutilonis* Spegazzini" in Saccardo (1892), Syll. Fung. 10: 676. (Origin of attribution to Spegazzini; followed in print by nearly everyone except H. C. Greene, 1945.)

≡ *Alternaria abutilonis* (Spegazzini) Brinkman, in Wollenweber (1932), Sorauer's Handb. Pflanzenkr., ed 5, III(2), p. 713. A Wollenweber attribution to Brinkman (1931), incorrectly interpreting a Brinkman list of names of *Macrosporium* species (l.c., p.6), which, he said, very likely (*zeer waarschijnlijk*) are *Alternaria*. However, Brinkman made no new combinations from this list.

≡ *Alternaria abutilonis* (Speg.) Joly (1964), Encycl.Mycol. 33: 192.

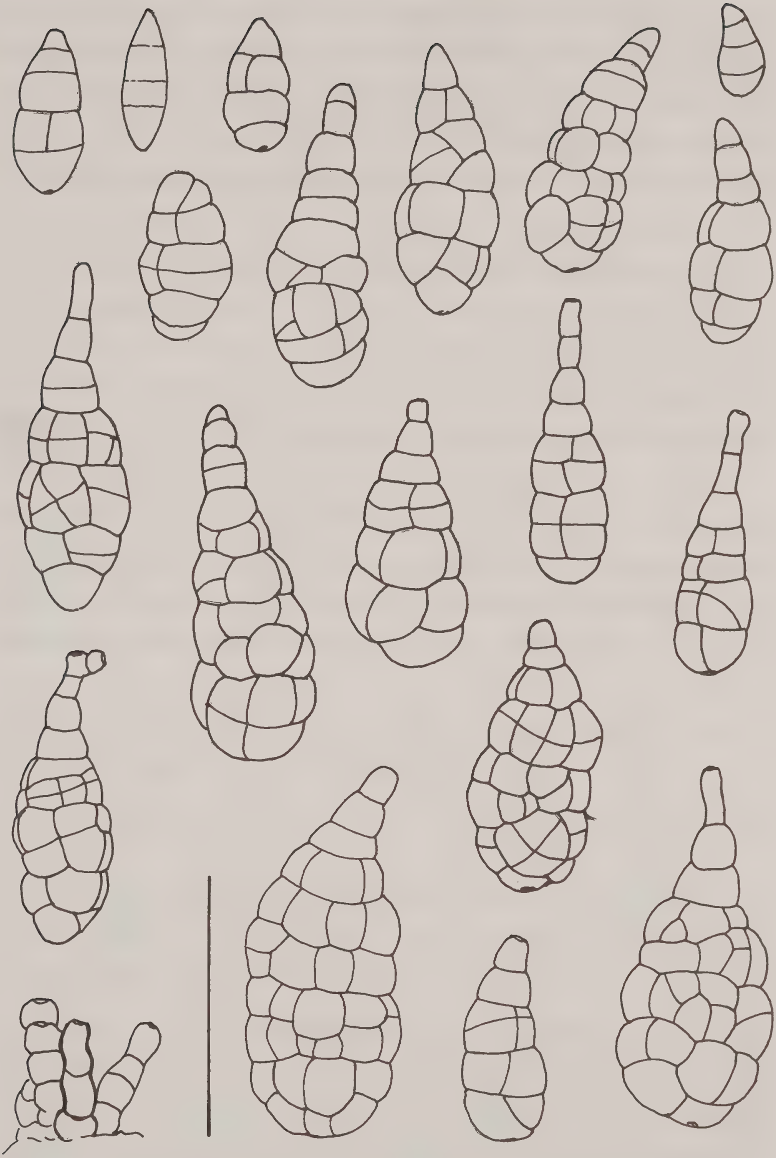

Fig. 225. *Alternaria hibiscina*: conidia and conidiophores ex lectotype **BPI** 445324 (EGS 49-107). Bar = 50μm.

Passerini described conidia of his *Macrosporium abutilonis* as obclavate, 5-7-transeptate with longisepta inserted, 50-90 x 10-15μ including an attenuate beak about as long as the spore body. This fairly represents the sort of conidia of moderate size with an apical filamentous beak that are found in the type—a taxon that falls readily into the *Alternaria tenuissima* species-group of the genus but that cannot be distinguished more precisely within the group.

Having examined a single slide preparation of the **BPI** lectotype of *Alternaria abutilonis* very early in my trek into *Alternaria* taxonomy (1954), I thought it would be a simple task to clarify the synonymy, homonymy, and misattributions involved—and, with dispatch, to characterize the seldom cited *Alternaria* material on *Abutilon* substrates. However, a second examination of the lectotype in 2003 (EGS 49-113) seemed necessary in order to check some discordant elements in my earlier drawings of conidia.

The result is that the dominant conidia of the first slide match the taxon that Passerini described as *Macrosporium abutilonis,* as indicated above and illustrated (Fig. 226). The few discordant elements of that first slide integrate without ambiguity into another *Alternaria* conidium population that dominates the second preparation; the second taxon is quite different from *A. abutilonis*

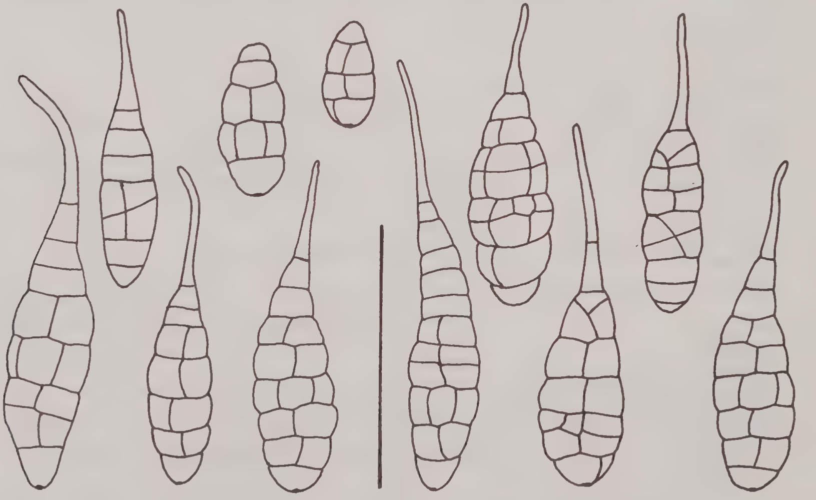

Fig. 226. *Alternaria abutilonis*: conidia ex lectotype **BPI** 445014 (EGS 07-101; 49-113). Bar = 50μm.

when a broad range of conidia is considered—it is described as novel in *Alt.T&V* 332, a decision that is bolstered by finding other examples of this novelty in a Nuttall collection in West Virginia and a Bartholomew collection in Kansas, both on *Abutilon theophrasti*. An examination of several other *Abutilon*-based *Alternaria* specimens (mostly **BPI** and **IMI**) shows that most of them represent small-spored taxa that cannot be grouped readily within the genus in the absence of isolates.

316. **Macrosporium malvae** Thümen (1879c), Ber. Bot. Vereines Landshut 7: 178.

Type specimen unknown. The entire type description is given here for reference purposes: *M.[acrosporium] hyphis erectis, septatis, subramosis; sporis maximis, longipedicellatis, erectis, pyriformibus, septatis, ad septas constrictis, griseis, 58 mik. long., 17 mik. crass. In foliis putridis Malvae neglectae. B.[ayreuth] am Ostbahnhof. 10. 74.*

Thümen, like many other mycologists of the time, described conidia of *Macrosporium* taxa incorrectly as being pedicellate, the pedicel acting as an attachment structure—like the stem of a pear fruit—yielding "*pyriformibus*" as a conidium shape. His description of *M. malvae*, reinterpreted, is of obclavate conidia with a long beak, 58 x 17μm in size. This could be an *Alternaria*, given Thümen's usual concept of *Macrosporium*. It is unidentifiable without a specimen and remains a *species incertae sedis*.

317. **Alternaria spadicea** (Thümen) E. G. Simmons, comb. nov. Fig. 227

≡ *Macrosporium spadiceum* Thümen (1879b), Revue Mycol. 1: 58. Holotype [**BM**, Ravenel Herbarium]: *Carolina australis. Aiken ad Hibisci esculenti Lin caules emortuos. (No. 2,246.)–H. W. Ravenel*; (EGS 17-021).

Although Thümen described the fungus as spreading over the substrate of dead okra stems (*Abelmoschus esculentus*) and occupying it totally, the bit of stem in the Ravenel manuscript type packet contained only sparse hyphal growth and very few conidia when examined. Nevertheless, the conidia found there are precisely as Thümen described them, if we observe the usual caveat that he considered *Macrosporium* spores to have a pedicel attachment—which always turns out to be a beak when conidia are *Alternaria*—and that his terms clavate and pyriform then become obclavate for us. His description can be interpreted in part as: conidia obclavate to long elliptic, short beaked, multiseptate, extremely constricted at the septa, the locules almost hemispherical, reddish brown, 40 x 16-18μm (including the beak).

Type conidia measured today actually are as large as 50-60 x 20μm; otherwise Thümen's observations on septa and locules are quite accurate. His phrase "*loculis fere hemisphericis*" is simply one way of noting that intraconidium cell formation is strikingly distoseptate, with the locules appearing hemispheric as they press against each other and against the strongly constricting eusepta—*septa maxime constrictis*—that also occur. The medium brown of conidium walls in the conserved specimen is appreciably darker than that of many similar growths, hence his epithet "*spadiceum*"—the color of dates or chestnuts.

There is no evidence of secondary conidiophore production on the few conidia seen (some broken). Experience suggests that conidia of this sort, when isolated, will produce chains in axenic culture, and probably did so in nature. The type of spore development and morphology is not rare, but no earlier name for the taxon exists in *Macrosporium* or *Alternaria*.

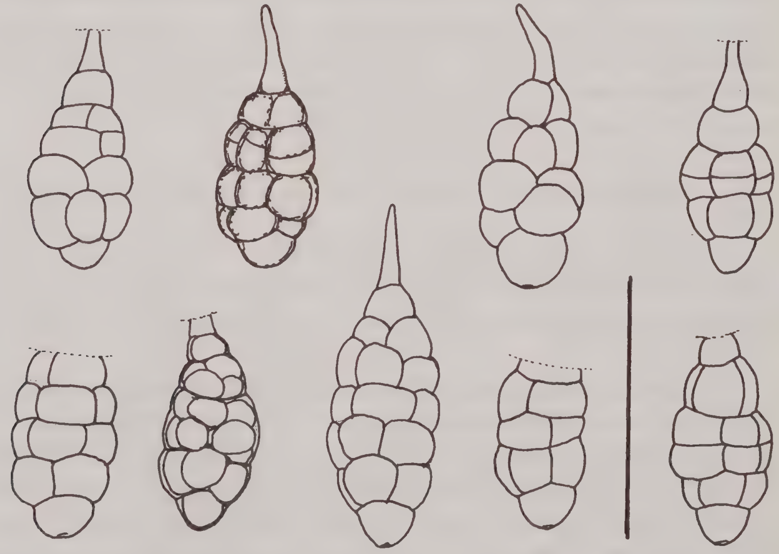

Fig. 227. *Alternaria spadicea*: conidia ex lectotype **BM**; Ravenel Herbarium (EGS 17-021). Bar = 50μm.

318. **Alternaria polytricha** (Cooke) E. G. Simmons (2000), Mycotaxon 75: 70.

≡ *Mystrosporium polytrichum* Cooke (1883), Grevillea 12: 33.

Cooke included specimens on malvaceous *Hibiscus (= Abelmoschus) esculentus* and *Gossypium* sp. when he described *M. polytrichum.* These two are among ten "syntype" substrates and Ravenel collections cited by Cooke (1883) in the type publication. In his treatment of *Alternaria* species on Solanaceae, Simmons (2000) reported examination of these specimens, discussed one of them in detail—Ravenel no. 2816 on *Solanum melongena*—and designated it in that place as lectotype of *M. polytrichum* and thus of *A. polytricha.*

319. **Macrosporium canificans** Thümen (1884).

This is a *nomen nudum* in Thümen's *Mycotheca Universalis no. 2280.* It was distributed as a collection made by H. W Ravenel in 1880 on dead stems of *Hibiscus (= Abelmoschus) esculentus* in South Carolina, U.S.A.

320. **Macrosporium canificans** Thümen, in Saccardo (1892), Sylloge Fungorum 10: 674.

Saccardo provided a description in Latin and cited *Macrosporium canificans Thüm. M.U. n. 2280 (absque diagnosi). Hab.in caulibus emortuis Hibisci esculenti, Aiken Carol. Austr. Amer. bor.*

I have examined two portions of the *Myc. Univ. 2280* distribution (**NY**; EGS 03-007, 03-127). Fungus elements are scanty; a very few *Alternaria* conidia were found. Assuming that Saccardo's description was based on an *Alternaria*, as were many of his *Macrosporium* entries, I found no *Alternaria* conidium as small as the size range given for the type—22-26 x 10-12μm.

Thümen is not noted for reluctance to publish new names on the basis of material sent by Ravenel. That he distributed this particular exsiccatus "*absque diagnosi*" indicates, perhaps, that he found no more to discuss than have I. The epithet "*canificans*"—producing grayness, hoariness, ash-color—presumably refers to substrate appearance. Given the history and physical support available for this taxon, I prefer to leave it as a *species incertae sedis.*

321. **Alternaria malvae** Roum. & Letendre, in Roumeguère (1885), Revue Mycol. 7: 177. Fig. 228

Lectotype (designated here) [**BPI**]: Roumeguère, Fungi gallici exsiccatı —Centurie XXXIV. no. 3393. 1885. *Sur les macules des feuilles arides du Malva crispa L. envahi par le Puccinia malvacearum Mont. Petit Couronne (Seine-Inférieure.) Septembre 1884. Abbé Letendre (221);* (EGS 51-112).

Portions of Roumeguère's *F. gall. exs. 3393* originally held at **BR**, **MO**, and **NY** failed to yield conidia of *A. malvae*. A copy at **BPI** provided fungus elements that match the type description, hence its designation as lectotype.

In addition to Roumeguère's conidium measurements, 34-54 x 9-14μm, two of his descriptive terms help in identifying the taxon (transl.): the conidia

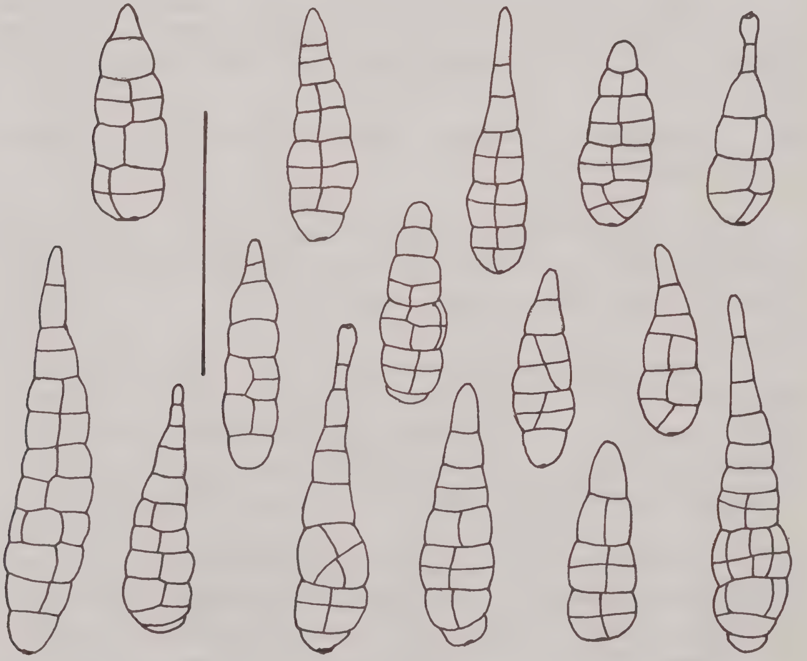

Fig. 228. *Alternaria malvae*: conidia ex lectotype **BPI**; Roumeguère, *Fungi gall. exsicc. 3393* (EGS 51-112). Bar = 50μm

are somewhat rounded or more often wedge-shaped. (A misprint "*caneiformes*" in the type description, etymologically untraceable, became clear in Saccardo's 1892 translation to "*cuneiformibus*" for the distinctive wedge shape.)

Conidia in all stages of development are bluntly rounded at base and apex, and they have a gradual taper from broad bottom to top. The largest conidia suggest but do not actually mimic fully developed conidia of some members of the *A. tenuissima* species-group, particularly when the median transverse septum of an *A. malvae* conidium sometimes becomes more constricting and darker than other septa.

Most conidia of *A. malvae* in the lectotype field specimen are solitary; only a few have developed a slightly enlarged apical cell that served as a secondary conidiophore in chain formation. Conidia are cuneate, that is, relatively broad and rounded at the base, gradually tapering upward to a single bluntly rounded apical cell; 30-78 x 10-14μm (Roumeguère's 54μm maximum length covers most of the conidia); with 4-12 transverse septa and 1 longiseptum in 3-7 of the transverse segments (2 longisepta in 1-2 segments of largest, broadest conidia). Some of the septa are constricting. Conidium color is a dilute yellow-tan; eusepta are only slightly darker. The outer wall appears to be smooth.

* * * * *

"*Alternaria malvae* C. & E." A note of nomenclatural clarification, of minor importance but for the record. Kawamura (1939) listed "*Alt. malvae* C. & E." as having been permitted importation to Japan from Holland by K. Nakata in 1929. There was no indication of intent to publish a new name attributable to Cooke and Ellis. The evidence indicates that almost certainly **CBS** sent a transfer of a culture labeled *Alt. malvae* C. & E. to Nakata, since the **CBS** catalogue for 1929 had this incorrect listing. Hara (1954) carried on this error.

322. **Stemphylium nigricans** (G. F. Atk.) E. G. Simmons, comb. nov.
Fig. 229

≡ *Macrosporium nigricans* G. F. Atkinson [as *nigricantium*] (1891), Bot. Gazette 16: 62. Lectotype (designated here) [**FH**]: *On leaves of Gossypium herbaceum, Leg. Geo. F. Atkinson, Auburn, Lee Co., Ala. August 1890.* [*1776 ex Herb. Geo. F. Atkinson Plantae Cryptogamae*]; (EGS 08-003).

≡ *Alternaria nigricans* (G. F. Atk.) Ciferri [as *nigricantia*] (1962), Ist. Bot. R. Univ. R. Lab. Crittog. Pavia, Atti, ser. 5, 19: 133.

In the summer of 1890 Atkinson surveyed his own collections as well as those obtained from cotton growers in Alabama. His focus was on a complex of leaf diseases known collectively as "black rust of cotton," which was prevalent and destructive in the region at the time. His identifications of the fungus taxa that were predominant in blackening masses on the leaves included species of *Cercospora*, *Colletotrichum*, *Alternaria*, and a "*Macrosporium*," the last of which he described as novel under the name *Macrosporium nigricantium*. Although the specimen "1776 ex Herb. Geo. F. Atkinson" in the Farlow Herbarium is marked TYPE, the history of Atkinson's study of large numbers of specimens in 1890 suggests that other specimens may exist elsewhere, perhaps also with a connotation of type; hence the designation of the **FH** material as lectotype. I have not seen another specimen that might challenge this selection.

As for the epithet "*nigricantium*" used by Atkinson, its construction in Latin is difficult to interpret or to justify as a derivative of its probable base "*nigricans*." Saccardo (1892) catalogued a correction, *Macrosporium nigricans;* and a few authors have followed his lead (Ferraris 1912; Sawada 1959). Other literature using the name is not abundant, so the correction adopted here in *Stemphylium nigricans* should not cause bibliographic distress.

It has been suggested in print, at least in 1960 (USDA Index of Plant Diseases in the United States), that the taxon is a *Stemphylium*. My earliest notes ca. 1954 on a pertinent specimen identify *Stemphylium* as the correct genus, and for many years the herbarium **IMI** has filed identified material of the taxon as *Stemphylium*. However, I can find no record of a formal transfer of this morphologically distinctive species to the genus and, therefore, have done so above.

Although literature abstracts occasionally (rarely) list a *Stemphylium* in discussion of cotton leaf lesions, the names used are *S. botryosum*, *S. solani*, or *S. vesicarium*. Any *S. solani* listing suggests to me that *S. nigricans* may have been encountered, as the two taxa are similar in having conidia with an apical protuberance (discussed below). Neither **ATCC**, **CBS**, nor **IMI** lists an isolate of *Stemphylium* from cotton—and I have none.

Modern reports of *Stemphylium* on cotton do not use the name that Atkinson assigned. Identifiers who used the Atkinson name in the 20th century rarely had the correct fungus; for the most part their conserved specimens range across several species-groups of *Alternaria*, including *A. macrospora*. Atkinson, however, knew the fungus that he had described from his 1890 Alabama collection well enough that he could identify it correctly in a specimen collected a year later in North Carolina (**BPI** 445378; EGS 07-115).

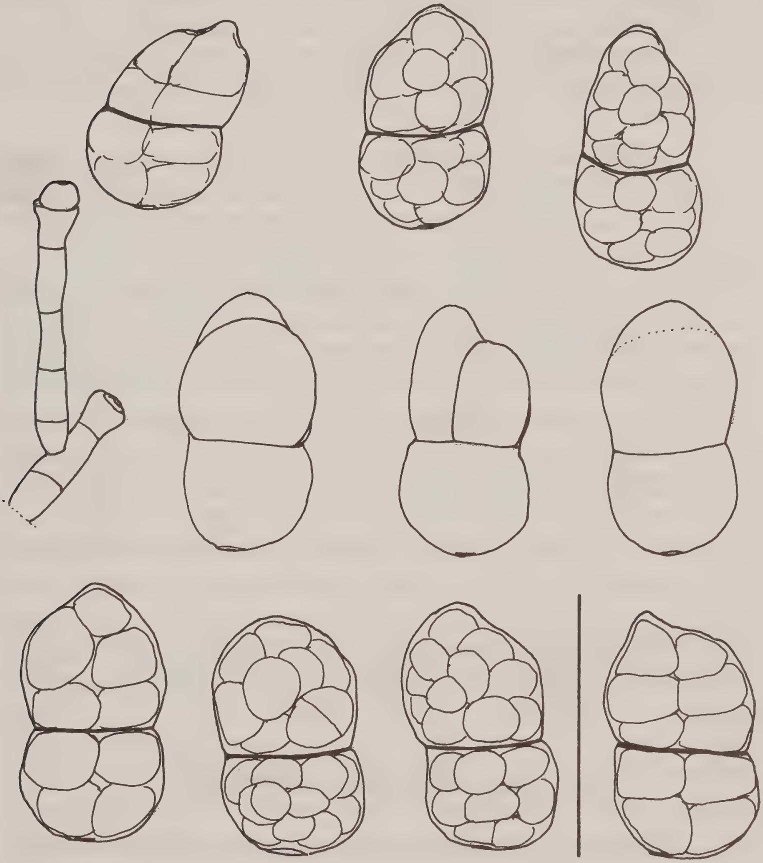

Fig. 229. *Stemphylium nigricans*: conidia and conidiophores ex lectotype **FH**; no. 1776 ex Herb. Geo. F. Atkinson Pl. Crypt. (EGS 08-003). Drawings in the middle line are an interpretation of one conidium turned on its longitudinal axis at 0°, 90°, and 180°. Bar = 50μm.

Conidia of *S. nigricans* are basically broadly ovoid—almost equilateral in one view but, at a 90° turn on the long axis, inequilateral and with one side of the apical region strongly rostrate. Upper size range is 45-50 x 20-28μm. Conidia are multicellular, although only a median transverse septum is well defined and constricting; otherwise, cell formation appears to be distoseptate, without discernible euseptation. Internal locules develop in as many as seven ill-defined transverse series and 3-4 longitudinal series. Conidium walls are smooth; conserved spores are almost colorless, whereas Atkinson described the originals as olive brown. Conidiophore fragments in the type have an apical, generically-typical flared conidiogenous cell and continued percurrent growth; they are about 45-50 x 7(-10)μm and, in nature, simple or branched.

This basic description for *S. nigricans* is only marginally exclusive to the taxon except for the asymmetry of the conidium and its eccentric rostrate cell, which Atkinson noted as "stoutly rostrate at one side of the apex." Small mammiform apicula are found on conidia of several species of *Stemphylium*, including members of a species complex centered on *S. lycopersici* (Enjoji) Yamamoto (1960). However, the broad rostrate apical cell of the *S. nigricans* conidium is not such a simple pointed apiculum. Instead it is terminal to only one longitudinal half of the spore, whereas the other parallel half remains rounded and shorter than the rostrate portion. Viewing a single conidium in three positions (diagrammed in Fig. 229): in a full view of the longest portion, the conidium appears simply broadly ovoid; at a 90° turn on the longitudinal axis, the differences in length and development of the apical cells are revealed; at a 180° turn, the rostrate half again appears as a broad oval but overlaid in part by the shorter half. It is noted that a somewhat similar condition is illustrated for *S. gossypii* X. G. Zhang & T. Y. Zhang (Zhang, X. G. et al. 2003), a taxon recently described from culture as having conidia 40-68 x 17-35μm with an average length of 54μm, which is greater than the maximum known for *S. nigricans*.

An aside on *Stemphylium solani* Weber

It is pertinent to discuss *Stemphylium solani* Weber (1930) in this place, in that I suspect that this name is being recorded in published abstracts for misidentified field material of *Stemphylium* on cotton. Conidia of many Weber specimens labeled "*S. solani*" at **FLAS** are, like those of *S. nigricans*, ovoid with a constricting median transverse euseptum. Internal cell formation is distoseptate, with transverse and longitudinal series of locules. A few conidia in many of these specimens are inequilateral to a minor degree, and the apical cell of the conidium often develops a small mammiform apiculum. I suspect, on examination of many Weber collections, in **FLAS** and elsewhere, that typification and routine identification of *S. solani* never have been established critically on the basis of his own material, which numbers two or three dozen known herbarium specimens. The subject requires a separate paper of its own.

In his original typifying paper, Weber (1930, p. 518) stated that there was "Type material in Florida Agricultural Experiment Station Herbarium" [**FLAS**]. Among numerous specimens there, one collected and determined by Weber is marked "(1-20-29). . .TYPE. . .sp. nov." (**FLAS** F13571, EGS 20-180). Weber retained numerous specimens at **FLAS** and distributed other specimens and cultures identified by him as *S. solani*. But his morphologic concept of the species was eclectic, and his attention to consistent identification of material deposited at other institutions almost cavalier.

The putative type material at **FLAS** contains two different *Stemphylium* taxa, neither of which is the same taxon as a Weber specimen no. 3689 at **BPI** (**BPI** 444705, EGS 07-013; labeled ex-Type but dated 3/17/'27—two years prior to the **FLAS** "Type"). Additionally, none of these fits Weber's published type description and illustration (1930); nor does the major component (of two) in his specimen at **NY** (dated 5/9/'35, EGS 06-078) or an isolate **IMI** 058140 (from Weber in 1940; EGS 20-010). Material ex-Weber that comes closest to agreeing with his type illustration is **BPI** 444704 (EGS 07-014), a specimen prepared from a dried culture labeled G. F. Weber Oct. 1, 1933 (too late to be type).

This is not the place to clear up the typification and identity of the *Stemphylium* species generally considered to be the agent(s?) of tomato grey leaf spot. However, from the standpoint of the name *S. solani* (on *Lycopersicon*) being used in the literature for typical *S. nigricans* (on *Gossypium*), it is sufficient to say that I have seen no specimen ex-*Lycopersicon*—originating with Weber or not—that bears conidia that are identifiable with those of typical *S. nigricans*.

323. **Alternaria tenuis** Nees f. **althaeae** Roumeguère (1896), Fungi selecti exsiccati 6902. *Alternaria tenuis Nees Formae Althaeae . . . Sur fruit de Hibiscus Syriacus, janv. 1896. F. Fautrey.* Also in Roumeguère (1896a), Revue Mycologique 18: 71.

The epithet of the forma *althaeae* is a nomen nudum in both places of publication. One portion of *Fungi sel. exs. 6902* (**NY**; EGS 02-171) yields relatively small conidia of at least one *Alternaria* taxon as well as of one *Ulocladium*. Neither is distinctive enough to pursue further in this discussion of taxa on Malvaceae. The name remains unsupported by a published description.

324. **Alternaria malvae-vulgaris** (A. G. Eliasson) E. G. Simmons, comb. nov. Fig. 230

≡ *Macrosporium malvae-vulgaris* A. G. Eliasson (1897), Bih. Kongl. Svenska Vetensk-Akad. Handl. 22: 18. Holotype [**UPS**]: *in foliis vivis Malvae vulgaris/Suecia: ad Flottsund prope Upsala. 15.8.1895/A. G. Eliasson*; (EGS 11-082).

Eliasson augmented his type description with a drawing of conidia that leaves little doubt as to the uniqueness of *A. malvae-vulgaris* (l.c., fig. 4), particularly when the type specimen also has remained available. He described and illustrated narrow-ellipsoid conidia with up to 12 transverse and only a few longitudinal septa; he did not mention or illustrate chain formation. The type supports his observations, in that conidia are narrow-ellipsoid or ovoid, have no beak portion distinct from the spore body, and lack secondary conidiophores. There is little resemblance to erostrate, non-catenate, large-celled conidia of *A. leucanthemi* Nelen (1962; *Alt.T&V* 20), *A rudbeckii* Nelen (1962; *Alt.T&V* 188), or *A. sonchi* J. J. Davis (in Elliott 1916; *Alt.T&V* 183). Literature subsequent to Eliasson refers to the taxon twice: as catalogued by Saccardo and Sydow (1899) and in a report by Nelen and Vasiljeva (1959). The latter report for Far-East USSR mentions conidia with hyaline filiform beaks 20-50μm long, which is a character not found in *A. malvae-vulgaris*.

Conidiophores in the only known collection, the type, are erect 2-celled hyphae 20-25 x 5-7μm with a conidiogenous apex and a short 1-celled geniculate branch, each with a pigmented alternarioid hilum. Conidia initially are narrow-ellipsoid. Some retain this shape and become 55-70 x 9-15μm, with 8-11 transepta and without longitudinal septa, or with only one longiseptum in each of two of the median transverse segments; other conidia become ovoid and 50-65 x 13-20μm, with 6-11 transepta and one longiseptum (rarely 2) in 1-6 of the transverse segments. (Eliasson noted and illustrated conidia as long as 100μm with 12 transepta.) The apex of each conidium is blunt; it never extends into any sort of beak. Conidium walls are smooth and medium brown.

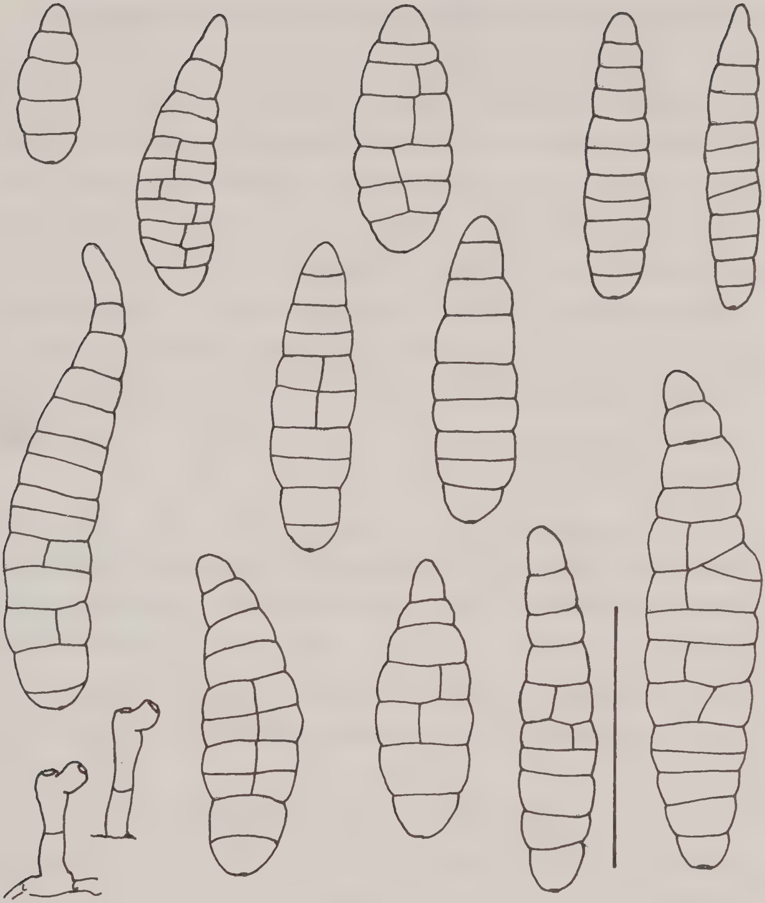

Fig. 230. *Alternaria malvae-vulgaris*: conidia and conidiophores ex holotype **UPS** (EGS 11-082). Bar = 50μm.

325–329. *Alternaria macrospora* and other taxa on Gossypium

Extra attention is paid here to this group of taxa, in that *Alternaria macrospora* is the major species of phytopathogenic importance among the malvacicolous taxa under review. Also, the species name appears to be in use for more than one taxon—a situation that deserves clarification. I have been able to examine conserved specimens and a few isolates of filament-beaked *Alternaria* from cotton substrates (mostly leaf spots) collected in cotton-growing areas of Africa, Asia, the Americas, and southern Europe. Many are identifiable as *A. macrospora*. Among several others that are not *A. macrospora*, only two known on *Gossypium* leafspots are discussed further below: some G. H. Jones specimens from Nigeria because they figure in early taxonomic literature on the group (*Alt.T&V* 326); and some specimens from Pakistan, Sudan, and Yugoslavia, because the fungus taxon present also occurs on U.S.A. *Abutilon* specimens (*Alt.T&V* 332).

Several other individual herbarium specimens of *Alternaria* on *Gossypium* that are not identifiable with taxa mentioned above would merit discussion if isolates were available for comparison. However, lacking cultures, I believe that publishing descriptions—much less names—for these entities would be pushing the taxonomic envelope a bit further than is warranted. It is obvious to me that species of *Gossypium*, as well as the entire Malvaceae, are likely to be generous sources of *Alternaria* and *Stemphylium* taxon novelties.

325. **Alternaria macrospora** A. Zimmermann [as "*makrospora*"] (1904), Ber. Land- Forstw. Deutsch-Ostafrika 2:24. Taf. II, fig. 13.
Fig. 231, 232

Lectotype (designated here): Zimmermann's illustration Taf. II, fig. 13, as noted above (ICBN Art. 8.1, 9.9). Zimmermann cited no individual collections. I have been unable to locate any collection that he may have examined. E. W. Mason (1928) had the same experience when he studied the species.

= *Sporodesmium longipedicellatum* Reichert (1921), Bot. Jahrb. Syst. 56: 723. Lectotype (designated here) [**B**]: *I. Reichert n. sp. . . .Hab. In foliis Gossypii sp. ad Bahtim prope Kahirahm, 15.Augusto 1912 (leg. Snell in Mus. Bot. Berol.!)*; (EGS 09-096). Two packets in herb. **B** bear the same source data; the one labeled "n. sp." is designated lectotype. And see *Alt.T&V* 326 for notes on G. H. Jones specimens involved in early discussions of the taxon.

=*Alternaria longipedicellata* (Reichert) Snowden (1927), Ann. Rept. Dept. Agric. Uganda Protectorate 1926: 31. An invalid name in that neither a basionym nor a reference source was cited (ICBN Art. 32.1.c). The entire Snowden entry reads: "An *Alternaria*, which is probably *A. longipedicellata* (Reichert) comb. nov., occurs frequently on leaves but probably follows other fungi." The name has no tradition of use.

≡ *Macrosporium macrospora* (Zimm.) Nisikado & Oshima (1944), Nogaku Kenkyu 36: 391. An invalid name (ICBN Art. 34.1). Although the authors introduced a "comb. nov." in 1944, as indicated, they did not use it (did not accept it) elsewhere in the paper. Instead, they used the name "*Alternaria macrospora* Zimm." consistently throughout the text as well as in the legend of their illustrations.

≡ *Macrosporium macrosporum* (Zimm.) Morsy (1969). Agric. Res. Rev. 47: 163. An invalid name (ICBN Art. 32.1.c), as neither the basionym nor its source was cited. In this 1969 paper the author stated that he also had made the new combination earlier in: Morsy, A. A. (1964): "Cotton *Macrosporium* in Tashkent region and its control." Ph.D. thesis Tashkent. (In Russian; not seen by EGS).

Trying to devise a typification concept for widespread *Alternaria macrospora* in the absence of type material has been like herding cats. One character seems to be holding in the right direction, then another branches off into a tree. However, a basic description can be established, with character variants noted. As there is no type or related specimen and no ex-type or related isolates, I take the opportunity here to designate a conserved herbarium specimen as the epitype of *A. macrospora*—to serve as an interpretative medium for the lectotype designated above.

Alternaria macrospora Zimmermann (1904); lectotype Taf. II, fig. 13 (l.c.); **epitype** (designated here) [**BPI** 841921; EGS 50-190]: a dried sporulating plate culture derived from P. J. Cotty C3H, ex *Gossypium barbadense* L., Arizona, U.S.A. Pertinent cultures are **ATCC** 58172 and **IMI** 390852.

The original and some subsequent concepts of *A. macrospora* have included what are, for the genus, moderately large conidia with a long filamentous beak. Zimmermann's illustration is of conidia 148-155 x 21-24μm (conidium body 86μm + beak 62-69μm long). For purposes of comparison, his illustration of conidia is entered here as Fig. 231, traced from an enlargement equaling that of my own drawings. The long-ellipsoid spore bodies of his two carefully drawn conidia have 11 partial or complete transepta and one longiseptum in 5-6 of the central segments (two in one segment). His text gives total conidium length as 150-170μm and conidium color as olive-green. Surface ornamentation is not mentioned. Zimmermann examined (presumably drew from) conidia produced on small fragments of cotton leaf lesions held on a coverglass in a damp chamber. He emphasized that only one conidium ever was produced on a conidiophore, that is, that he observed no chain formation or multiple conidiogenous sites on a single conidiophore.

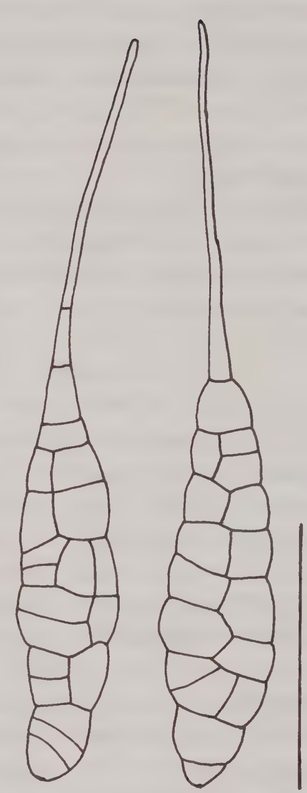

Fig. 231. *Alternaria macrospora*: conidia enlarged and traced from Zimmermann's lectotype illustration. Bar = 50μm.

Isolates from the type region (eastern Africa, specifically Tanzania) are not listed in international collections. Strains used in the current study originated from the southern U.S.A. (Arizona and Louisiana, isolated by P. J. Cotty) and from Mexico (my own isolates derived from USDA intercepts of cotton leaves with sporulating lesions). All of these, with one exception, fit a concept of *A. macrospora* that I have developed on the basis of available herbarium and isolated material. I believe that the concept is consistent with Zimmermann's.

Using the ex-epitype strain as the standard, *A. macrospora* growth on PCA is of inconspicuous surface and subsurface vegetative mycelium bearing very abundant, but not crowded, conidiophores and their conidia directly from the agar surface. There are essentially no non-sporulating hyphae or aerial mycelium in cultures of this strain under standard growth conditions. In cultures of the two isolates from Arizona (EGS 50-190, 50-191) and two from Mexico (EGS 36-028, 36-029) the hyphae of the thin but heavily sporulating surface mycelium do not respond well to routine light/dark cycles within the routine 7-day growth period, in that there is almost no evidence of concentric rings of heavy conidium production alternating with less-conidial hyphal rings within a routine 7-day growth period.

Growth of *A. macrospora* on V-8 agar (from which conidia are described and illustrated in Fig. 232) has only slightly more vegetative mycelium than that on PCA, but this is enough that sporulation occurs at several different levels—dense on the agar surface and scattered on meager aerial hyphae. Two or three concentric rings of sporulation are apparent without being clear cut. Sporulation throughout is very abundant, but with each conidium standing alone on its conidiophore without touching its neighbors except via entangled beaks.

Conidiophores arise from both subsurface and surface hyphae. They are ca. 50-200 x 5-6.5μm, medium brown, 3-10 transversely septate, and almost always have a single terminal conidiogenous site. Only rarely, under standard conditions, is a conidiophore found with a true branch or a geniculate extension with two spore scars; equally rare is production of a secondary catenulate conidium. Conidium bodies are long-ovoid or predominantly long-ellipsoid throughout development. Juvenile conidia ca. 30-40 x 7μm have 3-5 transepta when they initiate growth of a filamentous beak. The conidium body reaches a size range up to ca. 65-80 x 12-22μm and has up to 10-12 transverse septa. A single longitudinal septum forms in each of 3-6 of the widest transverse segments; a second longiseptum may be inserted in 1-4 of the widest segments of the largest conidia. Essentially all conidia develop an apical filamentous beak 1.5-2.5μm in diameter and as long as 170-350μm. The conidium outer wall is a medium greenish-brown (Zimmermann's olive-green), fading to a dull brown in lactic acid mounts, and is punctulate over most of the body surface.

Cell formation in conidia of *A. macrospora* is conspicuously distoseptate, both in conidia produced in culture and in those found in identifiable field specimens. The distoseptate condition remains obvious even after the formation of the few brown, slightly constricting eusepta that may arise in well-developed spores.

Comparison of these characters noted in culture with those of Zimmermann's type description reveals no forbidding differences. Maximum body size of type conidia (ca. 86 x 24μm) does not differ significantly from that seen in V-8 culture (ca. 80 x 22μm). There are, however, striking differences in the lengths of the filamentous beaks. Zimmermann noted that beaks in the type were about the same length as the conidium body, whereas beak lengths in the epitype isolate commonly are a striking 2-4 times as long as the spore body. Field conidia that yielded the ex-epitype culture (Arizona) are no longer available for guidance. Here, however, the Mexico specimens that produced equally identifiable isolates become instructive, in that their conserved field conidia have beak lengths up to only ca. 80-85μm, whereas their cultured derivatives have lengths of up to 250-300μm. The beak-length character, therefore, must be interpreted in the context of the growth conditions, in field or culture.

Character variants that provoked the "herding cats" complaint above fall into categories of number and color of eusepta (which are not abundant in representative isolates, but sometimes are numerous and pigmented in field spores), surface ornamentation (present but inconspicuous in most isolates, but lacking or indistinct in the field), chain formation (practically absent in good representatives), and beak length (moderate in the field, extremely long in culture). Allowing for the subtropical climate of cotton producing areas, most of these variables are acceptable in identifying field specimens from cotton leaf lesions: more eusepta and more longisepta than in type, varying ornamentation of conidium surface, evidence of chain formation in renewed natural growth, and relatively short filamentous beaks. However, unconditional characters for *A. macrospora* as a cotton leaf pathogen grown in pure culture must include moderately large ellipsoid conidium bodies with conspicuously distoseptate cell development, long filamentous beaks, and ornamented outer walls.

The major exception mentioned above among available isolates is Cotty CN089-2J, isolated in 1989 from *Gossypium barbadense* at New Orleans, Louisiana (EGS 50-192). Contrasted with the listed Arizona and Mexico isolates: colonies of the Louisiana isolate show very distinct concentric rings of light/dark-influenced growth and sporulation; sporulation is abundant on aerial mycelium developed in dark-phase rings; chains of two or three conidia are very common on aerial hyphae; large, abundantly septate conidia sometimes are beakless; and wall ornamentation often is conspicuous.

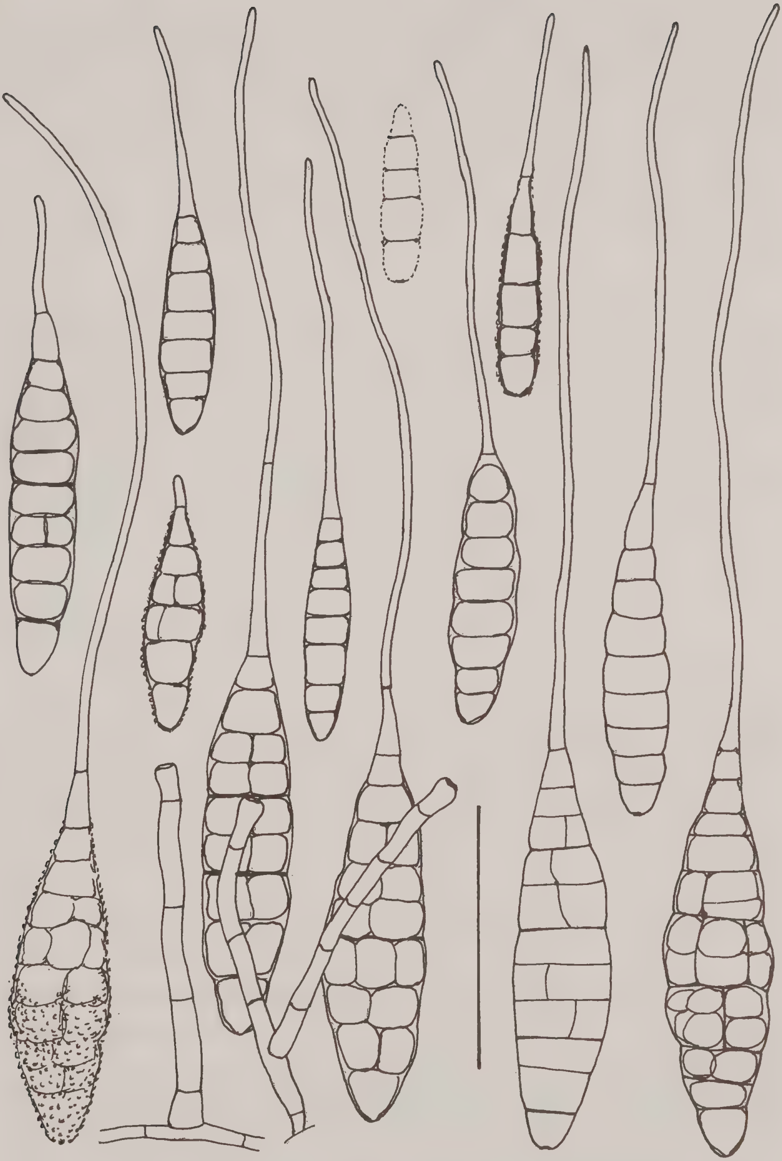

Fig. 232. *Alternaria macrospora*: conidia and conidiophores ex epitype **BPI** 841921 (EGS 50-190) on V-8. Bar = 50μm.

Still, this Louisiana isolate is identifiable with other more nearly typical isolates of *A. macrospora*—although at first I struggled mightily against accepting it as such and still consider it an atypical oddity. The critical factor lies in specifying the part of the population to be examined—a point often missed in culture comparisons. In the case of this Louisiana isolate, the colony responds to the light-dark regimen in a manner that differs from that of the other isolates observed—it grows and sporulates differently in the presence or absence of light.

By examining only the conidium population produced in the Louisiana isolate in colony rings that developed after exposure to light, it is seen that conidia are practically identical with those of the Arizona ex-epitype isolate—solitary, long-elliptical, predominantly distoseptate, and with very long filamentous beaks. In this case, most of the confusing character variation, absent in the epitype, arises in sporulation on the dark-phase aerial mycelium—relatively small conidium bodies, chains of conidia, occasional absence of beaks on mature conidia. We—certainly I—know too little about the differential effects of a light/dark cycle on a varied assortment of isolates of single taxa.

Several specimens examined in this study that are identifiable as *A. macrospora* are listed with their source data in an *Appendix*. The list is representative but not exhaustive of material seen. All record numbers are EGS: Egypt (EGS 09-096), Ethiopia (23-187), Guinea (36-042), India (36-030), Malawi (23-186), Mexico (36-028, 36-029), Nicaragua (36-027), Sudan (23-136, 23-192), Tanganyika (23-188), Trinidad (23-189), U.S.A (Arizona 36-046, 36-048, 50-190, 50-191, 51-058; Arkansas 36-047, 36-050; Louisiana 50-192; Texas 35-071).

326. ***Alternaria longipedicellata*** and ***A. macrospora***; some history notes.

G. H. Jones (1928) wrote at considerable length on "An *Alternaria* Disease of the Cotton Plant" that he studied in Nigeria. In observations on his isolates in culture, he remarked that they never were seen to develop a red or yellowish pigment. This was a character that had been discussed with E. W. Mason, who compared ex-cotton isolates from Uganda and Trinidad (considered to be *A. macrospora*) with those from Nigeria and observed (1928) that the "strains from Uganda and Trinidad were strongly chromogenic on certain media; the Nigerian was not."

Both Jones and Mason were questioning whether or not there were two different taxa with filament-beaked conidia that were separable by means of pigment production in culture. They decided to maintain a single name, *A. macrospora*, for such taxa found on cotton.

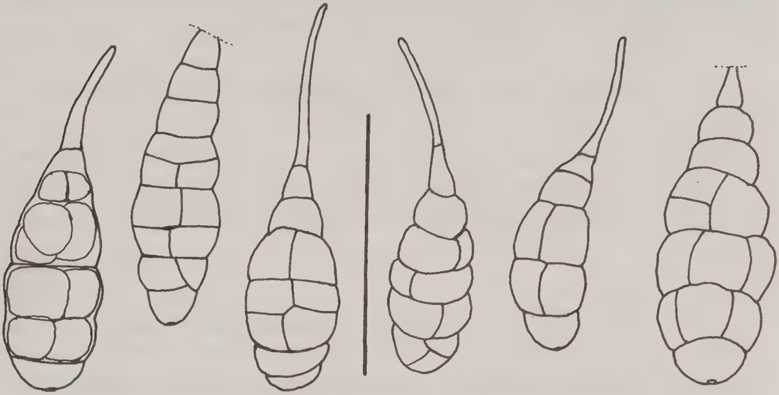

Fig. 233. *Alternaria* sp.: conidia ex G. H. Jones specimen, Nigeria, on cotton; **B** (EGS 09-099) and **IMI** (EGS 23-190). Bar = 50μm.

Portions of one of Jones's collections, with a determination attributed to S. P. Wiltshire, are at **B** and **IMI** (EGS 09-099 and 23-190; Fig. 233). If this specimen fairly represents the taxon studied in Nigeria—a debatable proposition—then Jones had a species different than *A. macrospora*. The 1920s isolates involved in these comparisons and observations were not retained. Conidia of the Jones material are sufficient for a negative opinion with regard to *A. macrospora*, but not for support of identity with another named taxon. Cultures of Mexico and U.S.A. isolates used in this current review do not produce visible amounts of pigment when grown on PCA, V-8, or Hay agars under stated conditions.

327. **Alternaria gossypii** (Jaczewski) Nisikado, Kimura & Miyawaki (1940), Ann. Phytopathol. Soc. Japan 19: 219.

≡ *Macrosporium gossypii* Jaczewski (1929), Mikrobiolog. Zhurnal (Leningrad) 9: 164, fig. 3. Lectotype (designated here): Jaczweski's illustration "fig. 3" cited in the type description (in transl.): *On cotton fibers.*

Conidia obclavate or oval, with 2-3 transverse septa; solitary or in short chains, sometimes with one oblique or longitudinal septum, 22-27 x 9-11μm. No pertinent specimen is known. Jaczewski's illustration is of two oval spores, each with three transverse septa; the printed enlargement at 150X yields an indistinct image only 4mm. long. It is not possible to translate the description and illustration into that of an identifiable *Alternaria* taxon.

Nisikado et al. (1940) discussed an isolate from cotton fibers that had conidia 13-55 x 5-15μm and 1-4(-5) transepta. They noted that conidia of their isolate showed differences from those described by Jaczewski, but suggested that (in transl.): the fungus which Jaczewski (1929) records certainly belongs to the genus *Alternaria* and should properly be called *Alternaria gossypii* (Jacz.) comb. nov.

The name *Alternaria* (or *Macrosporium*) *gossypii* occurs in a small number of lists of fungi on cotton fibers and on a few herbarium packets. However, the taxon has no tradition of precise definition and remains unidentifiable on the basis of the available information.

328. **Alternaria humicola** Oudemans var. **gossypii** Forsteneichner (1931), Phytopathol. Z. 3: 397, Abb. 14, 15.

Lectotype (designated here): Forsteneichner's illustrations "Abb. 14, 15" published with the type description (in transl.): *The fungus may attack the radicle as well as the hypocotyl of young cotton plants. Conidia occur in chains of 3-7 units and are round, oval or clavate, 11-55 x 11-15μm, with 1-8 transepta and sometimes some longisepta, constricted at the septa, eventually dark olive-green with finely ornamented walls.* No pertinent specimen is known.

Forsteneichner considered the fungus to be pathogenic to cotton seedlings. Bremer et al. (1948) and Göbelez (1964) have used the name in discussing the pathology and occurrence of cotton disorders in Turkey. However, in the absence of a specimen or culture, it is not possible to identify the taxon more closely than that it probably is a small-spored *Alternaria* with dark, rough conidia, or possibly a *Ulocladium* with similar attributes.

329. **Stemphylium gossypicola** (Nisikado) E. G. Simmons, comb. nov.
Fig. 234

≡ *Thyrospora gossypicola* Nisikado, in Nisikado and Oshima (1944), Nogaku Kenkyu 36: 392, Pl. 2. Lectotype (designated here): Drawings in Plate 2 of the cited publication; description and collection data: *Habitat in foliis vivis Gossypii herbacei, cultae (Malvaceae) Tsingtau, Shangtung, China, 9.IX.1942. (No. 32); Tsutshan, Kiangsu, China, 27.IX.1942. (No. 52, 53).*

Nisikado's illustration is chosen as lectotype because I never have been able to find evidence of the existence of any of his collections. He was a well-published myco-phytopathologist at the Ōhara Institute for Agricultural Research, Kurashiki, Japan, in the first half of the 20th century and produced excellent descriptions and drawings of *Alternaria* and *Stemphylium* taxa that he studied; the loss of his collections is a significant one.

He described the taxon (in transl.): conidiophores erect, solitary or fasciculate, simple, 3-5-septate, dark brown, 65-130 x 4.5-6.5μm, slightly inflated at the apex; conidia acrogenis, subsarciniform, ovate-ellipsoid, with a papillate apex, rounded base, transversely 1-septate (rarely 2-5), longitudinally 0(-1-2)-septate, subconstricted at septa, outer wall sparingly granulose, brown, 32-70 x 13-20μm.

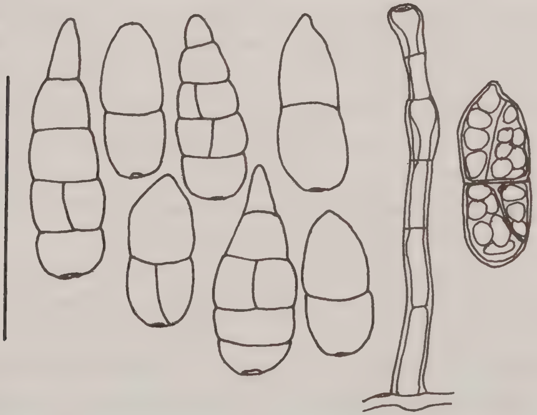

Fig. 234. *Stemphylium gossypicola*: conidia and conidiophore enlarged and traced from Nisikado's lectotype illustration. Bar = 50μm.

Nisikado's illustration is included here at an enlargement equal to that of other figures in this paper (Fig. 234). In the drawing of one conidium he shows precisely how cell formation begins and remains as mostly distoseptate in many *Stemphylium* species, with only a single constricting median transverse euseptum and sometimes additional eusepta in larger spores. The papillate structure of the *Stemphylium gossypicola* conidium apex is not the same kind of modification as the rounded protuberant apex found in *S. nigricans*; and the conidia of *S. gossypicola* are smaller and less cellular than those of *S. solani*, although the papillate apex is similar in both. (See discussion of these species in *Alt.T&V* 322 above).

Stemphylium gossypii X. G. Zhang & T. Y. Zhang (X. G. Zhang et al. 2003) has been described on the basis of material on leafspots of *Gossypium* collected in Shandong Province, China. The conidium cell structure and apex indicated in the illustration of this taxon are similar to those of *S. gossypicola*. Conidium size ranges of the two taxa overlap—32-70 x 13-20μm for *S. gossypicola*; 39-61 x 17-31μm for *S. gossypii*—but overlapping dimensions can be misleading without comparisons in culture.

The genus name *Thyrospora* Tehon & Daniels (1925) was used only for a few years, and mostly by authors in Japan, until Wiltshire (1938) clarified its synonymy with *Stemphylium*. Nisikado (Nishikado in his early papers) adopted, evidently without conviction, the poorly reasoned decision of Tehon and Daniels to erect a genus *Thyrospora* for a taxon misidentified by them as *Macrosporium sarciniforme* Cavara (≡*Stemphylium sarciniforme* (Cav.) Wiltshire 1938). Nisikado sometimes even used the style "*Thyrospora* (=*Stemphylium*)." In any case Nisikado's excellent drawings are of a *Stemphylium* as the genus now is generally understood. His taxon is discussed here because, like *S. nigricans* (*Alt.T&V* 322, above), its type substrate was leaf lesions of cotton and its conidial character of an apical papillate extension requires comparison with similar taxa sometimes cited as *Gossypium* pathogens.

330. **Alternaria hibisci** Bouhot (1966), Bull. Soc. Mycol. France 82: 294.

The name is invalid, having been published without a required Latin description or diagnosis (ICBN Art. 36). Bouhot's collection originally was at Institut National de la Recherche Agronomique, Versailles: *Sur feuille d'Hibiscus esculentus, début mai 1964, à Cambérène dans le Cap-Vert, au Sénégal*. I have examined the specimen (EGS 21-068), but there were very few conidia present. Although these half-dozen spores fit within Bouhot's published characterization of a taxon, they are not now sufficient basis for validating the name by supplying a Latin description. The name remains invalid

331. **Alternaria rosa-sinensis** M. X. Gao & T. Y. Zhang, in Zhang, T. Y., and M. X. Gao (2000), Mycosystema 19: 454.

Holotype [**HMUABO** 53932], isotype [**HSAUP** 950875]: *Hab. in foliis vivis Hibisci rosa-sinensis L. (Malvaceae), Guangzhou, Guangdong provincia, 12 IX 1982, Leg. J. Y. Li et D. F. Zhang.* Type material has not been available on loan for examination.

Conidia of *A. rosa-sinensis* were described as solitary, dark brown, obclavate, straight or slightly curved, with 6-11 transverse septa, 0-8 longitudinal or oblique septa, slightly constricted at main septa, conidium bodies 49.0-72.5 x 9.5-16.5μm; rostra filiform, very pale brown or subhyaline, septate, 46.5-155.5 x 1.5-3.5μm.

The authors say that *A. nigricantium* (Atk.) Ciferri and *A. macrospora* Zimm. are somewhat similar to *A. rosa-sinensis*, but that *A. nigricantium* has wider conidia (18-22μm wide) and lacks filiform beaks and that *A. macrospora* has wider conidia (15-22μm). As shown above (*Alt.T&V* 322), the type of *Macrosporium "nigricantium"* Zimm. (≡ *Alternaria nigricans*; ≡ *Stemphylium nigricans*) is a distinctive *Stemphylium*. The broad conidia of *A. macrospora* distinguish that taxon readily from *A. rosa-sinensis*, especially if conidia of the latter retain their narrow character in culture.

332. **Alternaria malvacearum** E. G. Simmons, sp. nov. Fig. 235, 236

Etym.: L., of Malvaceae (including here *Abutilon* and *Gossypium*)

Conidia in juventute ellipsoidea vel anguste ovoidea, cellula apicalis obtusa; conidia matura anguste obclavata, ad 80-110 x 13-18μm, 7-10(-13) transverse constricte septata, in segmentis multis transversalibus 1-2 longiseptata,, dilute brunnea, laevibus. Habitatio typi in laesionibus foliorum Abutilon theophrasti Medik., West Virginia, U.S.A. Holotypus: ***BPI*** *445907, Flora of Fayette County, W. Va., no. 1836, L. W. Nuttall lectum, 21.vii.1895 (EGS 36-036).*

Juvenile conidia of *A. malvacearum* are ellipsoid or narrow-ovoid and at first have a simple, bluntly rounded apical cell. This erostrate condition often persists until conidia become 30-40 x 8-12μm and have 4-6 transverse septa and 1(-2) longisepta in 1-5 of the transverse segments. At about this stage of development the apex of the enlarging conidium body begins to elongate into a gradually tapering, transversely septate beak-like extension, which, however, never is filamentous. The largest conidia are narrow-obclavate, reaching a maximum size range of ca. 80-110 x 13-18μm; the tapered beak portion varies in a range of ca. 10-40 x 5μm near its base to 3μm near its blunt apex. The beak apex of many conidia swells slightly as it converts into a conidiogenous cell; it may develop further into a second geniculate conidiogenous cell. The conidium body itself has 7-10(-13) transverse septa, of which 5-6 usually are distinctly constricting, and 1-2 longisepta in most of the transverse segments of the body. Conidium color is a dilute tan, against which background the well-defined eusepta are a strong brown. The conidium wall appears to be smooth.

Conidia of *A. malvacearum* have a long-narrow, compactly dictyic, well-constricted appearance that sets them apart from conidia of *A. abutilonis*, also described from *Abutilon*. *A. abutilonis*, as typified and described by Passerini (*Alt.T&V* 315, above) has conidia that are good representatives of the *A. tenuissima* species-group: conidia mostly ovoid, with a constricting median septum and a filamentous beak. Ironically, sporulation of *A.malvacearum* occurs in the type collection of *A. abutilonis,* on *Abutilon theophrasti*, as collected by Passerini in Italy. But it does not figure in Passerini's description of *A. abutilonis* and needs not to cause confusion.

The *A. malvacearum* type collection on "*Abutilon abutilon*" (= *A. theophrasti*) in Nuttall's *Flora of Fayette County, W. Va.* (misidentified as "*Macrosporium abutilonis* Speg.") is an abundant, well-conserved specimen without obvious *A. tenuissima* species-group characteristics. *A. malvacearum* is known also as a collection on *Abutilon* sp. collected in 1886 in Illinois (EGS 36-037) and possibly Kansas (see Addendum notes to this *Alt.T&V* 332). Although typified on *Abutilon*, *A. malvacearum* also has been found on leaf spots of *Gossypium* from several countries, and thus is widespread enough that it should be possible to find it for isolation and culture. However, I believe that I never have seen it as an isolate, assuming that it retains its diagnostic field features in culture. A very good collection on *Gossypium barbadense* L. is known from Sudan (EGS 23-137, Fig. 236); others on *Gossypium* species are from Pakistan (EGS 23-126) and Yugoslavia (EGS 23-130).

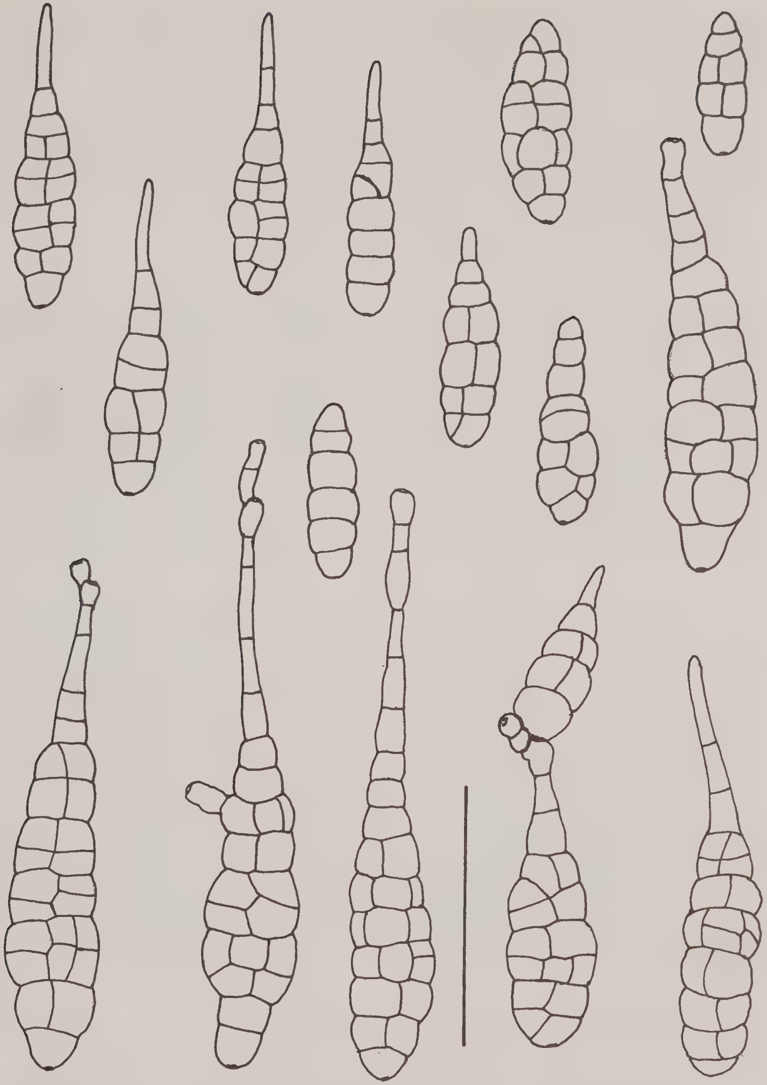

Fig. 235. *Alternaria malvacearum*: conidia and conidiophores ex holotype **BPI** 445907 (EGS 36-036). Bar = 50μm.

Alternaria malvacearum differs from *A. macrospora* on *Gossypium* in several ways: conidia of *A. malvacearum* are relatively narrow-ellipsoid, constricted at several well-pigmented eusepta, and tapered but not filament-beaked in the apical portion—the broader ovoid conidia of *A. macrospora* are conspicuously distoseptate with only moderate constriction at a few eusepta, and they have a narrow filamentous beak both in nature and in culture. It should be possible to distinguish the two taxa readily from each other, even if they occurred on the same *Gossypium* leaf or leaf spot.

Addendum to *A. malvacearum.* Although I have refrained from commenting on most of the interesting, even definable miscellaneous herbarium specimens not treated here as named taxa, a specimen on *Abutilon theophrasti* from Kansas (EGS 06-159) merits a place in these notes. The specimen is good; conidia are abundant in all stages of development (Fig. 236); and as a field specimen it can readily be distinguished from *A. malvacearum* (Fig. 235). However, there is enough morphological overlap with this latter taxon that I feel diffident about handling the Kansas entity as a new species—which was the original intent.

Conidia of the Kansas taxon become awl-shaped early in development and mature with a long tapered upper half that is transeptate but rarely has longitudinal septa; transverse eusepta are not strongly constricting; the general appearance is of restricted septum formation in even the largest conidia. In comparison, conidia of typical *A. malvacearum* are narrowly long-ovoid or long-ellipsoid, often with a narrow base cell; upper transverse segments may or may not have longisepta; several transepta and longisepta are distinctly constricting; the general appearance is of early and abundant cell formation, with well-defined, well-pigmented septation. With hopes of enlightening isolates eventually being found, I do not propose separation of the two sporulation types at present—even though they are distinguishable on the basis of their field characteristics.

333. **A. anodae** E. G. Simmons, sp. nov. Fig. 237

Ex cultura in agaro V-8 descripta. Conidiophora abunda, simplicia, 50-100 x 5-8µm. Conidia solitaria, anguste ovoidea denique late ovoidea, ad 50-75 x 20-25µm, distoseptata demum ex parte transverse euseptata, 7-8 transverse septata, 1-3 loculis distoseptatis in 4-6 segmentis centralibus; erostrata vel rostro filamentoso 50-80 x 1.5-2.5µm; laevia vel inconspicue punctata, dilute brunnea, hilo basali atrobrunneo. Habitatio typi in laesionibus

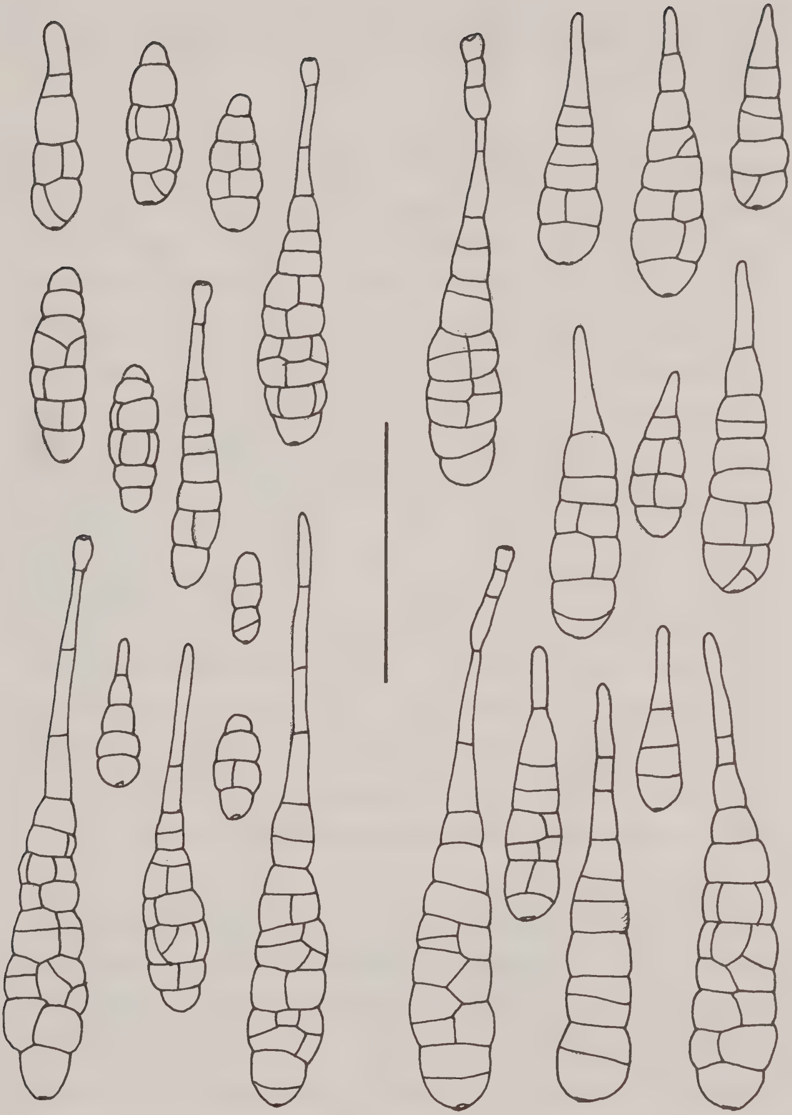

Fig. 236. *Alternaria malvacearum*: left, conidia ex *Gossypium*, Sudan (EGS 23-137); right, conidia ex *Abutilon*, Kansas, USA (EGS 06-159). Bar = 50μm.

foliorum Anoda cristata (L.) Schltdl., Mississippi, U.S.A., H. L. Walker antea ix.1981 lectum. Holotypus [BPI 842290]: lamina vitrea ex cultura EGS 35-070 in agaro V-8 crescente.

Conidiophores of the ex-type isolate of *A. anodae* are produced in abundance on the V-8 agar surface. They are 50-100 x 5-8μm, often swelling into the conidiogenous apex. Conidia usually are solitary, narrow-ovate becoming broad-ovate, reaching a size range of 50-75 x 20-25μm. Internal cell formation remains distoseptate throughout conidium enlargement, eventually becoming transversely euseptate in part, but rarely with a longitudinal euseptum; there are 7-8 transverse septa (of which 4-6 become euseptate) with 1-3 distoseptate locules in each of 4-6 of the broadest central segments. Each conidium usually produces a simple filamentous beak 50-80 x 1.5-2.5μm, although some of the largest spores remain erostrate with only a blunt-conical apical cell. Juvenile conidia have a minutely pustulate surface ornamentation, which may disappear as the spore enlarges or may be retained in maturity as a punctate roughening.

Conidia produced on PCA and on V-8 (the latter used in typification for purposes of comparison) are very dilute tan with a dark basal hilum that mirrors the dark brown hilum visible in the conidiophore apex. Transverse eusepta are slightly darker than the outer wall, as is the rare longitudinal euseptum. Conidia produced on a low-nutrient hay-decoction agar tend to have a few more longitudinal septa and are conspicuously darker brown in color. No evidence of secondary conidiophores leading to chain formation has been seen among conidia produced on V-8 or PCA under standard growth conditions; a few chains of two conidia are found in colonies produced on Hay agar.

A second specimen of *A. anodae* based on a cultured isolate provides some variant characters (EGS 36-052). This material is a conserved herbarium preparation of the isolate grown on sterilized bits of *Anoda* stems and leaf petioles plated on agar. Conidiophores often bear branches near the apex, each of which shows a relatively large, dark hilum. Conidia follow the same pattern of development seen in the ex-type isolate: broad-ovate conidium bodies, usually with a filamentous beak, conspicuously distoseptate cells, ornamented spore surface. However, in this specimen filamentous beaks reach lengths of 100-250μm, euseptum formation is more abundant than in the type, and short chains are readily found. Secondary conidia arise from conidiophores that are produced either directly from the apical cell of the primary conidium or from 1-celled conidiogenous swelling that terminated growth of a filamentous beak.

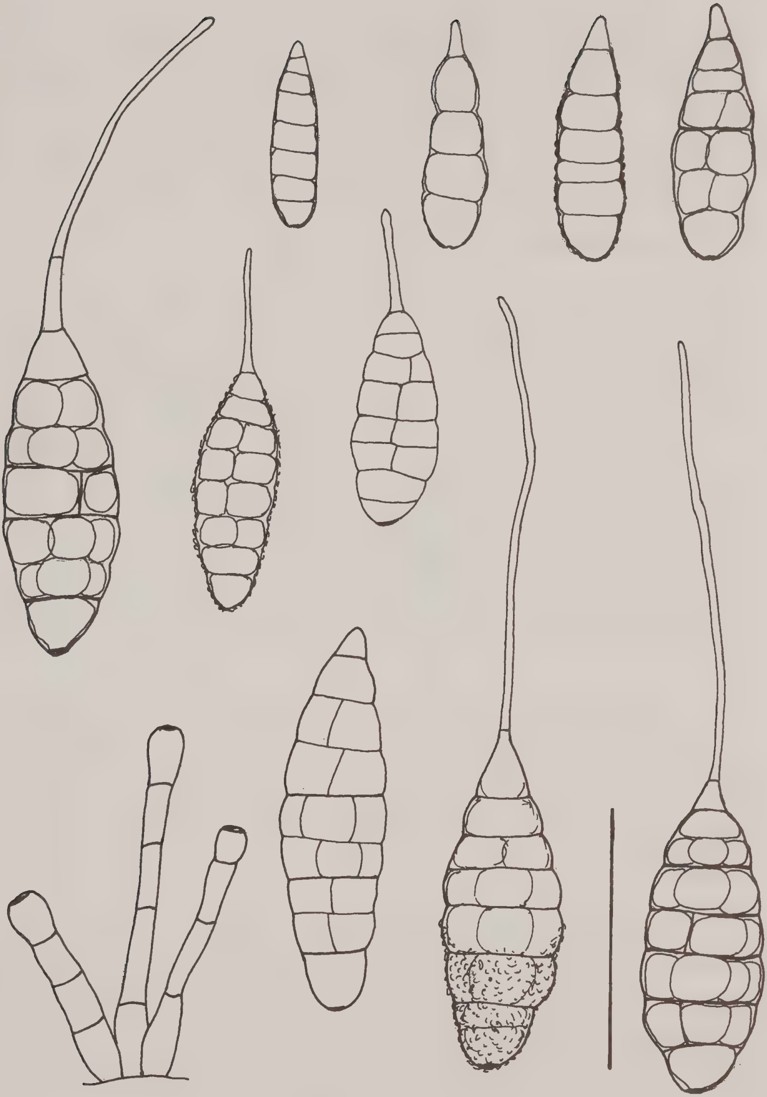

Fig. 237. *Alternaria anodae*: conidia and conidiophores ex holotype **BPI** 842290 (EGS 35-070) on V-8. Bar = 50μm.

All material of *A. anodae* that I have seen (including some photographs of typical conidia, EGS 51-039) originated in Mississippi, U.S.A., from staff of the USDA Southern Weed Science Laboratory, Stoneville, Mississippi. Attempts to evaluate *A. anoda* in biocontrol of *Anoda cristata* among field crops were active there when the isolate was received in 1981. The isolate from which the holotype slide preparation was prepared has been lost from culture.

334. **Alternaria sidae** E. G. Simmons, sp. nov. Fig. 238

Ex cultura in agaro V-8 descripta. Conidiophora maxime abundantia, erecta vel ascendentia 300-600 x 4-7µm, simplicia vel ramificantia, dilute brunnea, septata. Conidia solitaria, in juventute ellipsoidea, distoseptata, minute pustulata, denique longielliptica, erostrata vel plerumque rostro filamentoso; conidia ad 70-110 x 18-27µm, 7-9 constricte transverse septata, in 5-6 segmentis centralibus 1-2 longiseptata, dilute brunnea, septis fuscatis, laevia vel inconspicue punctata, rostra filamentosa ad 95-110 x 1.5µm sed vulgo curtiora vel etiam setacea 10-20µm longa. Habitatio typi in laesionibus foliorum Sida fallax Walp., Canton Island, Phoenix Islands, O. et I. Degener no. 24,609, 11.ii.1958 lectum. Typus: partes ex cultura EGS 12-129 desiccata et in ***BPI*** *842291 (holotypus) et saltem in* ***IMI*** *390853 (isotypus) conservandae*

Colonies of *A. sidae* on PCA and V-8 are remarkable in being composed of enormous numbers of erect or ascending primary conidiophores that commonly reach 300-600µm in length before they bear a conidium. Light-induced sporulation at an advancing colony edge forms dark concentric rings close to the agar surface, but the major area of the colony is a turf of the long conidiophores.

Conidiophores may remain simple in ex-type cultures on V-8, or more commonly they produce a few lateral branches or renew geniculate growth near the apex. The sturdy conidiophores are 4-7µm diam. throughout their length, subhyaline near the agar substrate, dilute tan above, with various numbers of transepta depending on conidiophore length. Conidia in the ex-type isolate are solitary; only rarely does a secondary conidium arise from the converted apex of an initial conidium (one per many thousands).

Conidia are narrow-ovoid or almost elliptical in youth; they develop into maturity in some close variant of a long-elliptical shape. The conidium initially is beakless, with a blunt-conical apical cell; many conidia remain

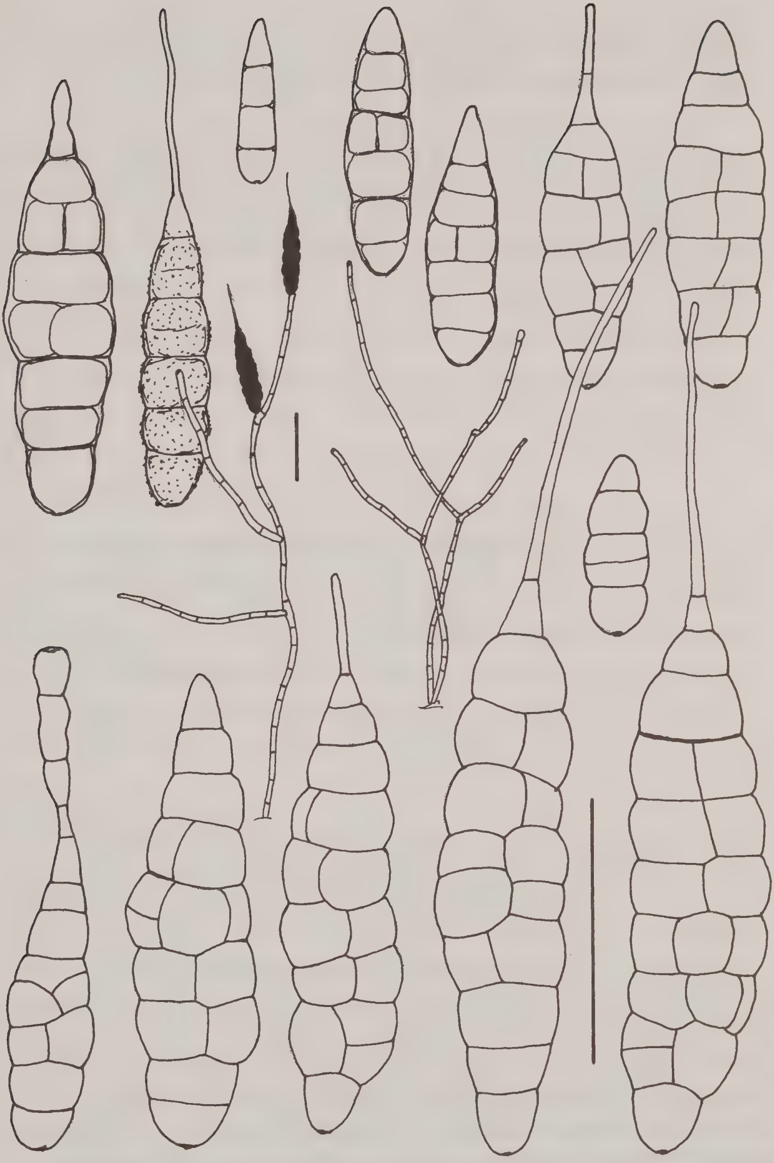

Fig. 238. *Alternaria sidae*: conidia and conidiophores ex holotype **BPI** 842291 (EGS 12-129) on V-8. Bars = 50μm.

beakless as they enlarge. However, the common pattern is for a conidium to produce an apical filamentous beak, which may begin development on juvenile conidia or later on large, multicellular, sub-mature spores.

Young conidia of *A. sidae* begin cell formation in a conspicuous pattern of distoseptate locules, but constricting eusepta soon are inserted and become a dominant character. Juvenile conidia often have an overall minutely pustulate surface; this ornamentation or simple surface roughness usually disappears as the outer wall area increases. Conidia mature in a common upper size range of ca. 70-110 x 18-27μm, with 7-9 constricting transverse septa and 1-2 longisepta in 5-6 of the central transverse segments; mature conidium color is a dilute tan with eusepta slightly darker. Filamentous beaks sometimes reach 95-110 x 1.5μm, but usually are somewhat shorter or even occur as a short bristle only 10-20μm long.

The type isolate was derived from a field specimen passed to me 45 years ago by C. T. Rogerson as an interesting *Alternaria* on leafspots of *Sida fallax* Walp. collected by O. and I. Degener in the Phoenix Islands (now part of Kiribati in the west equatorial Pacific Ocean). The isolate has survived the interim well as a freeze-dried preparation. A more recent isolate, awaiting comment for only ca. 20 years, originated in India as an isolate from *Sida acuta* J. Burm. (EGS 38-112). Field specimens that appear to be *A. sidae* are from Burma on *S. rhombifolia* L. (EGS 35-136), India on *S. acuta* (EGS 51-034), and Tanzania on *S. acuta* (EGS 35-135).

The India isolate requires comment because of its atypical pattern of conidium production. Colony growth and appearance are much as in the type. However, primary conidiophores are a medium brown and sturdy, almost stiff, throughout their remarkable length of ca. 500-600μm. They are not seen to branch but often have 1-2 scarcely geniculate extensions beyond the initial conidiogenous site. Additionally striking are the chains of 2-4 conidia that are produced abundantly by the India isolate—a character that is at odds with the solitary conidia of the type. Although the conidium body develops through the same pattern in both isolates, most filamentous beaks in the India isolate swell abruptly into strong, secondary conidiophores 5-7μm wide and 50-100μm or even 300μm long. Clues to the equivalence of the two ex-*Sida* isolates lie in the identity of the early development and intermediate septation pattern of conidia and in the presence in the India isolate of small numbers of typical conidia with a short apical bristle or filamentous beak of modest length.

Another comparison is appropriate. Conidia of *A. pseudorostrata* (*Alt.T&V* 147), like those of the India isolate of *A. sidae*, are produced in chains through the agency of prominent secondary conidiophores intercalated between successive conidia. Conidium bodies of *A. pseudorostrata* are the smaller and narrower of the two species: ca. 55-90 x 14-20μm vs. 70-110 x 18-27μm. Also, the very long conidiophores in young colonies of *A. pseudorostrata*, though never filiform in the sense of a 1-2μm width, are a supple, flexuous 3μm wide throughout a length of 100-200μm; even at full development they reach only ca. 4-5μm diam. and do not have the sturdy, almost coarse appearance of the 4-7μm wide conidiophores of *A. sidae*.

335. **Alternaria hibiscinficiens** E. G. Simmons & C. F. Hill, sp. nov.
Fig. 239, 240

Etym.: L., from *Hibiscus* + *inficiens* = infecting *Hibiscus* species (in this instance *H. sabdariffa* L. and *H. moscheutos* L.

Ex cultura in agaro V-8 descripta. Conidiophora abundantia, congesta, ca. 50-100 x 3-4μ, simplicia (sub luce), vel ad 300+μm, diverse ramificantia (absque luce). Conidia in juventute anguste ellipsoidea vel ovoidea, denique late ellipsoidea vel late ovoidea, solitaria, ad 70-90 x 16-25μm; erostrata, vel rostro filamentoso ad 60-80μm longo, vel conidiophoro secundario; 7-10 leviter constricte transverse septata, 1(-2) longiseptata in segmentis multis transversalibus, dilute vel modice luteobrunnea, euseptis fuscatis, non ornata; conidia in maturitate vulgo cellulis prolificis, ad 75-90 x 30+μm. Habitatio typi in laesionibus foliorum Hibiscus sabdariffa L., Fiji; specimen Auckland, New Zealand, vi.2002 interceptum; cultura Lynfield 676, C. F. Hill sejuncta (EGS 50-166). Typus: partes ex cultura EGS 50-166 desiccatae et in BPI 842292 (holotypus) et saltem in IMI 390854 (isotypus) conservandae.

All surface and aerial hyphal elements of colonies of *A. hibiscinficiens* produced on V-8 agar are conidiogenous. A colony less than 1 cm. diam. at 2d. already is producing conidia in the center half of the colony. At 4d. the 4 cm. colony shows three dark concentric rings of single conidia crowded on a turf of short conidiophores at the agar surface (light-phase growth). Less dense, intercalated rings (dark-phase growth) are composed of longer aerial conidiophores that are variously branched and always conidiogenous. The variant kinds of sporulation noted below tend to predominate in these rings of aerial growth.

Conidia initially are narrow-ellipsoid to ovoid, enlarging to broadly ellipsoid and broadly ovoid. The apical cell of the spore body is conical, often acutely so, and remains in this shape for much of the conidium population throughout development of conidia into their maximum size and septation. Although large numbers of these beakless, solitary conidia are conspicuous in the population, other conidia develop further in a variety of ways. Some produce a single simple filamentous beak; in others the apical cell extends into a strong secondary conidiophore; others produce additional secondary conidiophores laterally from 2-4 of the conidium body cells while the primary conidium still is attached to its own conidiophore; a few conidia produce a filamentous beak and a sturdy secondary conidiophore from the same apical cell; and still others produce germination hyphae from body cells, which hyphae then meander through the colony's upper sporulation thicket and eventually produce additional conidiophores and conidia. The inherent sporulation strategies of the taxon are wondrously variant under culture conditions.

Conidia may be as large as 50 x 14μm and have 6 transverse septa before the first longiseptum is inserted in one segment. More mature erostrate conidia as well as the spore bodies of filament-beaked and pseudorostrate conidia reach ca. 70-90 x 16-25μm in size before a significant amount of body-cell proliferation begins. Cell proliferation that inflates part of the spore outline occurs mostly in cells below the median transeptum; this is a type of conidium over-development found commonly in this taxon. Spore bodies in this condition may be either erostrate or beaked and reach sizes as great as 75-90 x 25-30+μm. Filamentous beaks seldom exceed 60-80μm in length. Although conidia become cellular through a process of distoseptation, they age with several eusepta among the 7-10 slightly constricting transepta and 1(-2) longisepta in most of the central transverse segments before submedian cell-proliferation becomes evident. A surface view of such conidia shows 15-18 cells; a similar view of conidia with cell proliferation shows a range of 17-23. Conidium color is a dilute to medium yellow-brown; eusepta are darker. The outer walls of young conidia are punctulate, those of older conidia not obviously ornamented.

Access to the Fiji material of *A. hibiscinficiens* on *Hibiscus sabdariffa* permitted me to resurrect notes and drawings from a specimen of the same taxon received in 1970 from Maryland, U.S.A., on leaf spots of *H. moscheutos* L. Isolated in 1970, it unfortunately was later lost from culture (EGS 29-181, reviewed recently from the **BPI** specimen as EGS 51-041). Conidia without cell

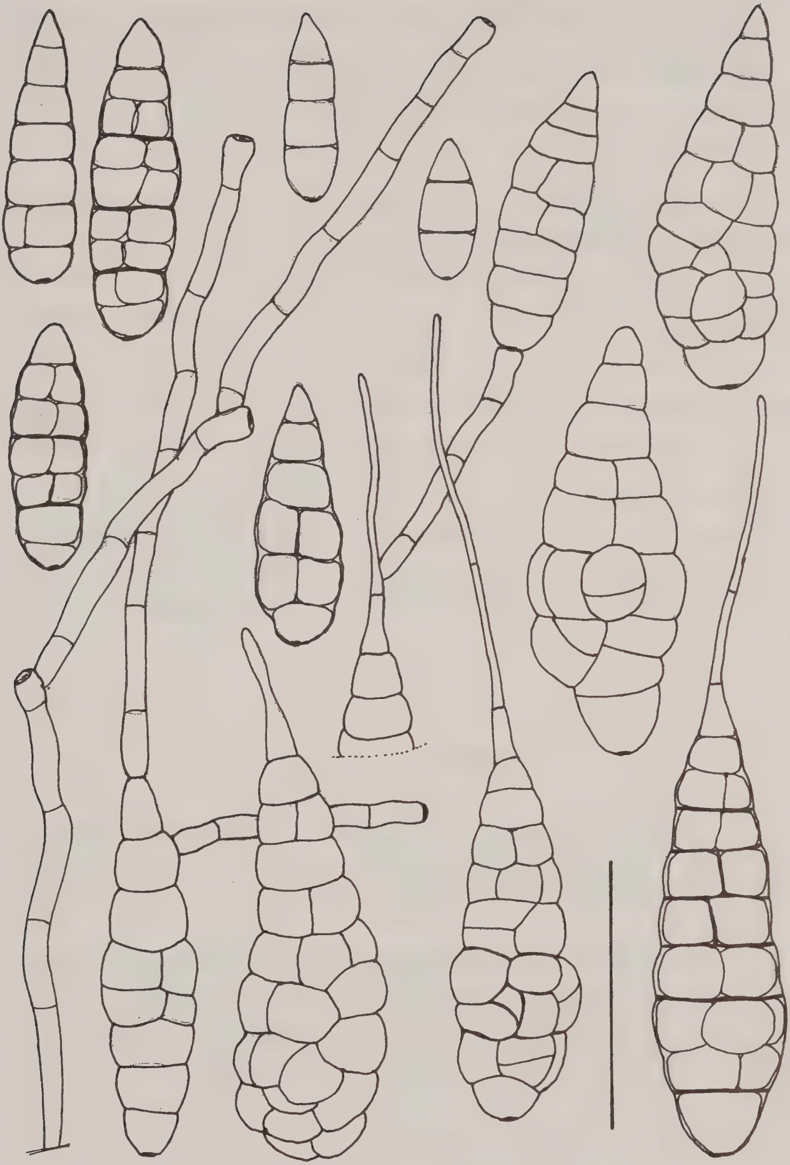

Fig. 239. *Alternaria hibiscinficiens*: conidia and conidiophores ex holotype **BPI** 842292 (EGS 50-166) on V-8. Bar = 50μm.

proliferation are identical in the isolates from Fiji and Maryland. Figure 240 records characteristics of a few field conidia (notably distoseptate) and of a flush of new conidia produced on a leaf lesion held overnight in a damp-chamber (erostrate and filament-beaked conidia with a rapid progression from disto- to eu-septation.

Several taxa of *Alternaria* on leaf spots of Malvaceae have a common character of conidia that initially are erostrate—the single apical cell of the conidium body may be bluntly rounded to acutely conical, but it is a unit of the spore body, not a separate beak structure. In *A. hibiscina* (*Alt.T&V* 314 above) the conidium apex is blunt and, in the type, never seen to develop further in any way except as a well-defined short secondary conidiophore with a terminal conidiogenous pore. In *A. hibiscinficiens* the apical cell of juvenile conidia often is rounded, but further development appears always to lead to a sharply angular, almost acute form that may proliferate as a secondary conidiophore, or as a filamentous beak, or even as both. In additional contrast of these two taxa, the largest conidia of *A. hibiscinficiens* have a surface view of ca. 18 cells in spores without cell proliferation; those of *A. hibiscina* 30-35—entirely different pictures of septation in conidia whose mature sizes often overlap.

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ACKNOWLEDGMENTS

Dr. M. E. Palm and Dr. R. P. Korf have provided highly valued pre-submission reviews of these *Alt.T&V* efforts—affording a quality and level of collegial support that is essential to their continuation.

Institutions that have lent specimens or shared isolates are noted in the text by means of standard acronyms. They are sincerely thanked, as are Dr. P. J. Cotty, Dr. H. L. Walker, Dr. C. T. Rogerson, and Dr. C. F. Hill, all of whom provided materials critical to the study as it developed.

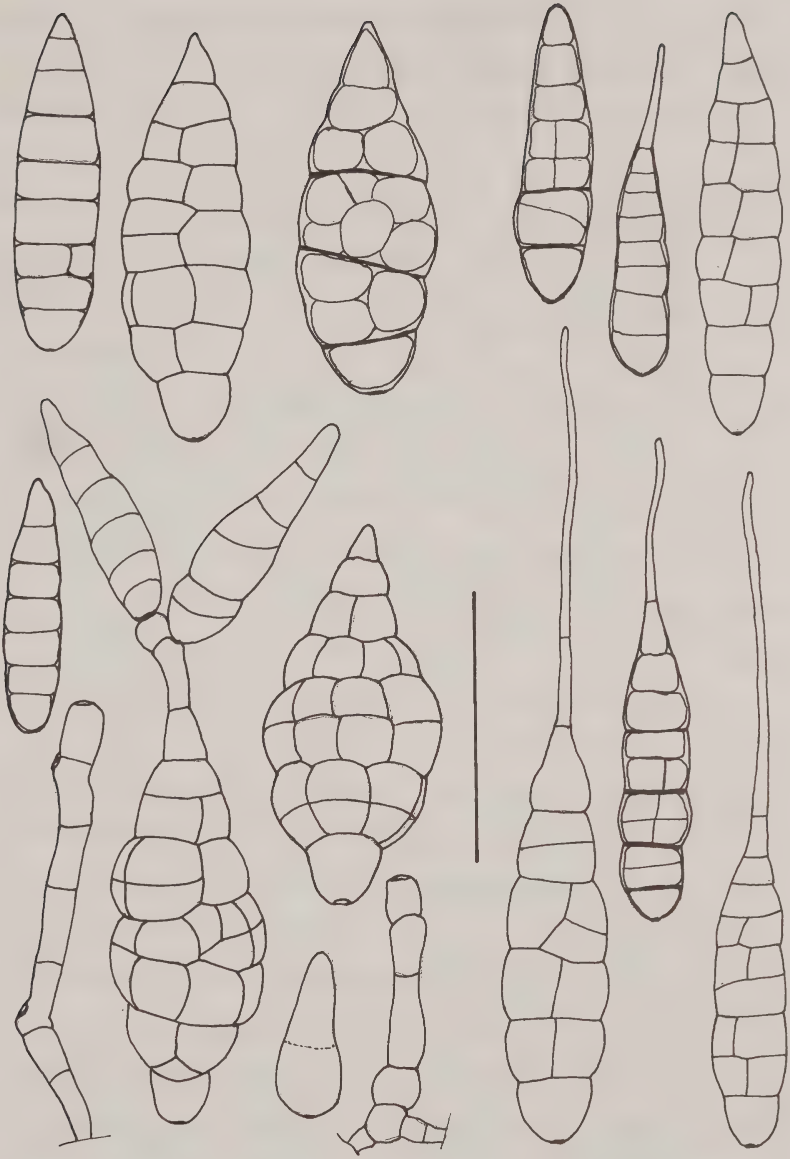

Fig. 240. *Alternaria hibiscinficiens*: conidia and conidiophores ex *Hibiscus*, Maryland, USA; left of bar, ex original specimen (EGS 51-041), and right, ex lesion overnight in damp chamber (EGS EGS 29-181). Bar = 50μm.

APPENDIX: Specimen/Isolate Source Data

EGS # EGS opinion **Source** "Source information" [*A.* = *Alternaria*]
[*S.* = *Stemphylium*]

02.171 [*nomen nudum*]: **NY** "C. Roumeguère. Fungi sel. Exs. 6902. Alternaria tenuis Nees f. Althaeae . . . Sur fruit de Hibiscus Syriacus, janv, 1896."

03.007 [*taxon incertae sedis*]: **NY** "Thümen, Mycotheca univ. 2280. Macrosporium canificans Thüm. . . . America septentr.: Aiken-Carolina australis /in caulibus emortuis Hibisci esculenti Lin. 1880. Leg. H. W. Ravenel."

03.055 *A. gossypina*: **NY** "Thümen, Mycotheca univ. 1469. Macrosporium gossypinum Thüm. . . . America septentr.: Aiken /Carolina australis /in Gossypii herbacei Walk. et Arn. Caulibus emortuis. 1876. Leg. H. W. Ravenel."

03.123 *A. gossypina*: **NY**. "Thümen, Mycotheca univ. 1469. Macrosporium gossypinum Thüm. . . . America septentr.: Aiken /Carolina australis /in Gossypii herbacei Walk. et Arn. Caulibus emortuis. 1876. Leg. H. W. Ravenel."

03.127 [*taxon incertae sedis*]: **NY** "Thümen, Mycotheca univ. 2280. Macrosporium canificans Thüm. . . . America septentr.: Aiken-Carolina australis /in caulibus emortuis Hibisci esculenti Lin. 1880. Leg. H. W. Ravenel."

06.078 *S.* spp.: **NY** "Stemphylium solani Weber /Hab. Lycopersicum esculentum /Loc. Bradenton, Fla. /Coll. G. F. Weber /Date 5/9/'35 /No. 11217."

06.159 *A. cfr. malvacearum*: **KSC** "North American Fungi Collected by Elam Bartholomew / Macrosporium abutilonis Speg. /Host. Abutilon Avicennae /Loc. Lyons, Kans. /Date Sept. 14, 1932 No. 11647."

07.003 *A. gossypina*: **BPI** "Thümen, Herb. mycol. Oeconicum 513. Macrosporium gossypinum Thüm., nov. spec. . . . Nord-Amerika: Aiken in Süd-Carolina auf abgestorbenen Stengeln der cultivirten Baumwolle, Gossypium herbaceum Walk. et Arn. Selten. Herbst 1876. Leg. H. W. Ravenel."

07.013 *S.* sp.: **BPI** 444705 "Stemphylium solani Weber /Hab. Tomato (cult.) /Loc. Bradenton, Fla. /Coll. George F. Weber /Date 3/17/'27 /Det. G. F. Weber No. 3689."

07.014 *S. cfr. solani*: **BPI** 444704 "Stemphylium solani Weber /On tomato / Gainesville, Fla. /G. F. Weber Oct. 1, 1933."

07.101 *A. abutilonis*: **BPI** 445014 "C. Spegazzini. Decades Myc. Italicae 58. Macrosporium Abutilonis Pass. n. sp. . . . Hab. Ad folia languida Abutilonis Avicennae / Parma in R. Horto Botanico. Aug. 1878. leg. Dr. G. Passerini."

07.115 *S. nigricans*: **BPI** 445378 "Macrosporium nigricantium Atk. On Gossypium herbareum /Zimmerman Station, N. C. /Coll. Geo. F. Atkinson no. 1971. July 14, 1891."

08.003 *S. nigricans*: **FH** "Macrosporium nigricantium Atkinson spec. nov.? /On leaves of Gossypium herbaceum /Leg. Geo. F. Atkinson /Auburn, Lee Co., Ala. August 1890."

09.096 *A. macrospora*: **B** "Sporodesmium longipedicellatum I. Reichert n. sp. . . . Hab. In foliis Gossypii sp. ad Bahtim prope Kahirahm, 15.Augusto 1912 (leg. Snell in Mus. bot. Berol.!)."

09.099 *A.* sp.: **B** "Alternaria macrospora /Host Gossypium peruvianum (native cotton) /Loc. Moor Plantation, Ibadan, Nigeria /Col. G. H. Jones / Det. Imperial Bureau of Mycology /Date aug. 1924."

11.082 *A. malvae-vulgaris*: **UPS** "Macrosporium Malvae-vulgaris n. sp. in foliis vivis Malva vulgaris /Suecia: ad Flottsund prope Upsala 15/8/1895 A. G. Eliasson."

12.129 *A. sidae*: E. G. Simmons isol. ex **NY** "Herb. Otto Degener fungi of Phoenix Islands / Alternaria on Sida fallax Walp. /coll. Otto & Isa Degener No. 24,609 /Two miles east of landing strip. Canton Island. 11 Feb. 1958."

17.021 *A. spadicea*: **BM** "H. W. Ravenel's Herbarium – Rec'd. 1891/ 2246 /Macrosporium spadiceum Thümen on dead stem of Hibiscus esculentis /Aiken, S. C. /H. W. R."

20.010 *S. cfr. lycopersici*: **IMI** 58140 "Stemphylium solani /isol. from Lycopersicon esculentum, Manatee, Fla. /G. F. Weber [to IMI in 1940]."

20.180 *S.* spp. [2]: **FLAS** "TYPE F13571 Stemphylium solani Weber sp. nov. /Hab. Tomato /Loc. Homestead, Florida /Coll. G. F. Weber /Det. G. F. Weber /1-20-39."

21.068 [*nomen invalid.*]: **INRA**, Versailles, France "Alternaria hibisci Bouhot /Sur feuille d'Hibiscus esculentus, début mai 1964, à Cambérène dans le Cap-Vert, au Sénégal. Leg. D. Bouhot."

23.126 *A. malvacearum*: **IMI** 92807 ". . . Host Gossypium sp. /Loc. Khanpur, Pakistan /Col. A. Chafoor & Mustafa, 29-10-60, ex Central Mycol. Herb. Karachi, Pakistan no. 4042."

23.130 *A. malvacearum*: **IMI** 54049 ". . . Host Gossypium (cotton) /Loc. Butel Exptl. Sta. Skopje, Macedonia, Yugoslavia /F. S. Parsons / 1 Nov. 1953."

23.136 *A. macrospora*: **IMI** 59663b ". . . Host Gossypium barbadense /Loc. Wad Med, Sudan /S. A. J. Tarr 2219 /10-10-54."

23.137 *A. malvacearum*: **IMI** 48504 ". . . Host Gossypium barbadense /Loc. Aden, A. E. Sudan /Col. S. A. J. Tarr 1266 /1951."

23.186 *A. macrospora*: **IMI** 119092 ". . . Host Gossypium hirsutum /Loc. Malawi /Col. D. Nurse 1686 /Comm. 9/5/66."

23.187 *A. macrospora*: **IMI** 116529 ". . . Host Gossypium /Loc. Ghibelg, Ethiopia / Col. D. Y. /9-27-64."

23.188 *A. macrospora*: **IMI** 4156 ". . . Host Gossypium (cotton) /Loc. Lubaga, Shinyanga, Tanganyika /Col. A. N. Prentice /Apr. 1943."

23.189 *A. macrospora*: **IMI** 967 ". . . Host Gpssypium (cotton) /Loc. I.C.T.A. Lab., Trinidad /Col. H. R. Briton-Jones /14-12-26."

23.190 *A.* sp.: **IMI** 963 ". . .Host Gossypium peruvianum /Loc. Moor Plantation, Ibadan, Nigeria /Col. G. H. Jones /Aug. 1924."

23.192 *A. macrospora*: **IMI** 61965a ". . .Host Gossypium sp. (cotton) /Loc. Neitejpi, Darfur, Sudan /Col. B. Beskin /26-10-55."

29.181 *A. hibiscinficiens*: **BPI** 446417 ". . .on Hibiscus moscheutos, Glendale, Maryland /Coll. H. F. Winters 20 Aug. 1970."

35.070 *A. anodae*: **BPI** 842290 ". . .ex leaf spot of Anoda cristata, USDA Southern Weed Science Lab., Stoneville, Mississippi, H. L. Walker, 1974? [before Sept. 1981]."

35.071 *A. macrospora*: [culture lost] ". . .ex cotton plant, Arizona, isol. H. L. Walker [before Sept. 1981]."

35.135 *A. sidae*: **IMI** 151212 ". . .Host Sida acuta /Loc. Ukiriguru, Mwanza, Tanzania /Col. D. L. Ebbels 27-4-1970."

35.136 *A. sidae*: **IMI** 172446 ". . .Host Sida rhombifolia /Loc. Mandalay /Col. Mya Thaung 28-11-71."

36.027 *A. macrospora*: **BPI** 446412 ". . .on Gossypium, Managua, Nicaragua /Aug. 15, 1954 /Coll. S. C. Litzenberger."

36.028 *A. macrospora*: E. G. Simmons isol. ex **BPI** 446413 ". . .on Gossypium sp. (leaf), intercepted at El Paso, 012191-Texas, 15 Jan. 1980."

36.029 *A. macrospora*: E. G. Simmons isol. ex **BPI** 446414 ". . .on Gossypium sp., intercepted at El Paso, 010279-Texas, August 22, 1979."

36.030 *A. macrospora*: **BPI** 446415 ". . .Gossypium hirsutum, Hebbal, Bangalore, India, 16.8.1966, Swaminathan."

36.036 *A. malvacearum*: **BPI** 445907 "Flora of Fayette Conty, W. Va., Collected by L. W. Nuttall 1890-1898 /Macrosporium abutilonis Speg., on Abutilon abutilon, No. 1836, July 21, 1895."

36.037 *A. malvacearum*: **BPI** 445906 ". . .On Abutilon, Chandlerville, Ill., Aug. 20, 1886 /Coll. A. B. Seymour #7133."

36.042 *A. macrospora*: **BPI** 445760 ". . .on Gossypium, Guinea, Sept. 19, 1964 /Coll. S. C. Litzenberger No. 133."

36.046 *A. macrospora*: **BPI** 446410 ". . .on Gossypium, Waldron, Ark., Aug. 23, 1924 /Coll. Dwight Isley."

36.047 *A. macrospora*: **BPI** 445768 ". . .on Gossypium, Waldron, Ark., Sept. 4, 1924 /Coll. V. H. Young."

36.048 *A. macrospora*: **BPI** 446409 ". . .on Gossypium, Phoenix, Ariz., Oct. 27, 1925 /Coll. D. C. George."

36.050 *A. macrospora*: **BPI** 445765 ". . .on Gossypium, Waldron, Ark., Sept. 4, 1925 /Coll. V. H. Young."

36.052 *A. anodae*: **BPI** 446407 ". . .on Anoda cristata /Coll. H. D. Ohr, 1975 [USDA Southern Weed Science Lab., Stoneville, Mississippi]."

38.112 *A. sidae*: **IMI** 291691 ". . .ex Sida acuta, India."

49.107 *A. hibiscina*: BPI 445324 "Thümen, Mycotheca univ. 979. Macrosporium hibiscinum Thüm. America septentr.: Aiken – Carolina australis – ad Hibisci esculenti Lin. Caules emortuis 1877. (no. 2247.) leg. H. W. Ravenel."

49.113 *A. abutilonis*: **BPI** 445014 "C. Spegazzini. Decades Myc. Italicae 58. Macrosporium Abutilonis Pass. n. sp. . . . Hab. Ad folia languida Abutilonis Avicennae / Parma in R. Horto Botanico. Aug. 1878. leg. Dr. G. Passerini."

50.166 *A. hibiscinficiens*: **Lynfield** 676 "ex leaf Hibiscus sabdariffa (roselle), intercepted Auckland from Fiji, June 2002."

50.190 *A. macrospora*: **Cotty** C3H ". . .ex *Gossypium barbadense* L., P. J. Cotty C3H, Arizona."

50.191 *A. macrospora*: **Cotty** C10K ". . .ex Gossypium barbadense L., P. J. Cotty C10K, Arizona."

50.192 *A. macrospora*: **Cotty** CN089-2J ". . .ex Gossypium barbadense L., P. J. Cotty CN089-2J, New Orleans, Louisiana, 1989."

51.034 *A. sidae*: **IMI** 264451 ". . .Host Sida acuta /Loc. Gorakhpur, India /Coll. R. P. Verma 161 /comm. 26.xii.1981."

51.039 *A. anodae*: **BPI** 446406 ". . .on Anoda cristata, Mississippi, 1974."

51.041 *A. hibiscinficiens*: **BPI** 446417 ". . .on Hibiscus moscheutos, Glendale, Maryland /Coll. H. F. Winters 20 Aug. 1970."

51.049 *A. gossypina*, etc.: **BPI** 445306 "Thümen, Mycotheca univ. 1469. Macrosporium gossypinum Thüm. . . . America septentr.: Aiken /Carolina australis /in Gossypii herbacei Walk. et Arn. Caulibus emortuis. 1876. Leg. H. W. Ravenel."

51.058 *A. macrospora*: **BPI** 444952 ". . .on Gossypium, Tucson, Arizona, Coll. H. A. Edson, Sept. 26, 1935."

51.112 *A. malvae*: **BPI** "C. Roumeguère, Fungi Gallici exsiccati 3393. Alternaria Malvae Roum. et Letendre . . . Sur les macules fauves des feuilles arides du Malva crispa L. Envahi par le Puccinia malvacearum Mont. Petit Couronne (Seine-Inférieure.) Septembre 1884. Abbé Letendre (221)."

LITERATURE CITED

Atkinson, G. F. 1891. Black rust of cotton: a preliminary note. Bot. Gaz. 16: 61-65.

Bouhot, D. 1966. Quelques champignons phytopathogènes nouveaux ou peu connus au Sénégal. Bull. Soc. Mycol. France 82: 274-300.

Bremer, H., H. İşmen, G. Karel, H. and M. Őkan. 1948 Tűrkiyenin parazit mantarlari űzerinde incelemeler. Beiträge zur Kenntnis der parasitischen Pilze der Tűrkei. III. Fungi Imperfecti. Istanbul Űniversitesi Fen Facűltesi Mecmuasi. Ser. B., 13: 1-53.

Brinkman, A. 1931. De Roodneuzen-ziekte van *Phaseolus vulgaris* L., veroorzaakt door *Pleospora herbarum* (Pers.) Rbh. Thesis, Univ. Amsterdam. 86 pp.

CBS. 1929. Centraalbureau voor Schimmelcultures, Baarn (Holland), List of Cultures 1929. Koninkl. Akad. Wetensch. Amsterdam. 47 pp.

Ciferri, R. 1962. Schedae Mycologicae XXXV-XCVIII. Ist. Bot. Reale Univ. Reale Lab. Crittog. Univ. Pavia. Atti, ser. 5, 19: 85-139.

Cooke, M. C. 1883. New American fungi. Grevillea 12: 22-33.

Corda, A. C. J. 1838. Icones Fungorum Hucusque Cognitorum. II. J. G. Calve, Prague. 43pp., Pl. VIII-XV.

Eliasson, A. G. 1897. Fungi upsalienses. Bih. Kongl. Svenska Vetensk-Akad. Handl. 22: 1-20.

Elliott, J. A. 1916. An *Alternaria* on *Sonchus*. Bot. Gazette 62: 414-416.

Farr, D. F., G. F. Bills, G. P. Chamuris, and A. Y. Rossman. 1989. Fungi on Plants and Plant Products in the United States. American Phytopathological Society. 1252 pp.

Ferraris, T. 1912. Flora Italica Cryptogama. Pars I: Fungi. Hyphales, Dematiaceae. Fasc. N. 8. (pp. 195-584). Cappelli, Rocca S. Casciano.

Forsteneichner, F. 1931. Die Jugendkrankheiten der Baumwolle in der Türkei. Phytopathol. Z. 3: 267-419. 19 figs.

Fries, E. 1849. Summa Vegetabilium Scandinaviae. Sectio posterior: pp. 259-572. Bonnier, Stockholm & Leipzig.

Gőbelez, M. 1964. La mycoflore de Turquie (List of Fungi of Turkey) II. Mycopathol. Mycol. Appl. 23: 47-67.

Greene, H. C. 1945. Notes on Wisconsin parasitic fungi. VII. Amer. Midl. Naturalist 34: 258-270.

Greuter, W. (chmn.), and Editorial Committee (eds.) of the International Association for Plant Taxonomy. 2000. International Code of Botanical Nomenclature. Regnum Veget., vol. 138. 474 pp.

Hara, K . 1954. [Nihon Kinrui Mokuroku.] A List of Japanese Fungi Hitherto Known. Nihon Kingakkai Kaihō. 447 pp.

Holmgren, P. K., N. H. Holmgren, and L. C. Barnett (eds.). 1990. Index Herbariorum, Part I: The Herbaria of the World. Regnum Veg. 120. 693 pp.

Hopkins, J. C. F. 1931. *Alternaria gossypina* (Thüm.) comb. nov. causing a leaf spot and boll rot of cotton. Trans. Brit. Mycol. Soc. 16: 136-144.

ICBN. International Code of Botanical Nomenclature. See: Greuter, G., et al. 2000.

Jaczewski, A. A. 1929. О некоторых болезнях волокна хлопчатника [Some diseases of cotton fibers.] [Mikrobiologicheskii Zhurnal (Leningrad)] 9: 159-167.

Joly, P. 1964. Le Genre *Alternaria*. Encyclopėdie Mycologique XXXIII. 250 pp.

Jones, G. H. 1928. An *Alternaria* disease of the cotton plant. Ann. Bot. (London) 42: 935-947.

Kawamura, T. 1939. A list of the bacteria and fungi imported and transported under permit into Japan Proper 1914-1938. Ann. Phytopathol. Soc. Japan 9: 243-262.

Krombholz, J. V. 1831. Naturgetreue Abbildungen und Beschreibungen der essbaren, schädlichen und verdächtigen Schwämme. Erstes Heft. J. G. Calve, Prague. 85pp., 6 Taf.

Mason, E. W. 1928. Annotated account of fungi received at the Imperial Bureau of Mycology. List II (Fascicle 1). Mycol. Papers no. 2. 43 pp.

Morsy, A. E-A. 1969. Fungus from the genus *Macrosporium* Fr. attacks cotton in U.A.R. Agric. Res. Rev. 47: 162-164.

Nelen, E. S. 1962. Новые виды *Macrosporium* Fr. и *Alternaria* Nees из Приморского Края. Species novae *Macrosporii* Fr. et *Alternaria* Nees a Prov. Primorskensi. Bot. Mater. Otd. Sporov. Rast. Bot. Inst. Komarova Akad. Nauk SSSR 15: 142-153.

———, and L. N. Vasiljeva. 1959. Патогенная микофлора цветочных растений в Дальневосточном Ботаническом Саду. [The pathogenic mycoflora of the flowering plants in the Far-East Botanical Garden.] Bjull. Glavn. Bot. Sada Akad. Nauk SSSR 35: 82-91.

Nisikado, Y., K. Kimura, and Y. Miyawaki. 1940. [On two *Alternaria* species injurious to cotton fiber in bolls.] Ann. Phytopathol. Soc. Japan 10: 214-230.

———, and T. Oshima 1944. [Black spot disease of cotton. Studies on the prevention of disease damage to cotton in Eastern Asia. (Report no.2)] Nogaku Kenkyu 36: 381-396.

Oudemans, C. A. J. A. 1923. Enumeratio Systematica Fungorum. Vol. IV. The Hague. 1231 pp.

Passerini, G. 1879. *Macrosporium abutilonis* Pass. n. sp.; n. 58, in C. Spegazzini, Decades Mycologicae Italicae 4-5-6 (n. 31-60). Sumpt. auct., Conegliano.

Rabenhorst, L. 1844. Deutschlands Kryptogamen-Flora, vol. I, Pilze. Leipzig: Kummer. 614 pp.

Reichert, I. 1921. Die Pilzflora Ägyptens. Eine mykogeographische Studie. Bot. Jahrb. Syst. 56: 598-727.

Roumeguère, C. 1885. Fungi Gallici exsiccati.–Centurie XXXIVe. Revue Mycologique 7: 167-178.

——— 1896. Fungi selecti exsiccati Cent. 70. Ed. F. Fautrey.

——— 1896a. Fungi exsiccati praecipuè Gallici. LXX centurie. Revue Mycologique 18: 71-82.

Saccardo, P. A. 1892. Sylloge Fungorum Vol. X. Suppl. univ. II. 964 pp.

———, and P. Sydow. 1899. [Saccardo's] Sylloge Fungorum Vol. XIV. Suppl. univ. IV. 1316 pp.

Sawada, K. (posth). 1959. Descriptive Cagalogue of Taiwan (Formosan) Fungi. Part XI. Spec. Publ. No. 8, Coll. Agric., Natl. Taiwan Univ. 268 pp. (Eds. R. Imazeki, N. Hiratsuka, H. Asuyama).

Schwarze, C. A. 1917. The Parasitic Fungi of New Jersey. New Jersey Agric. Coll. Exp. Sta. Bull no.#313. 226 pp.

Simmons, E. G. 1981. *Alternaria* themes and variations [1-6]. Mycotaxon 13: 16-34.

—— 1990. *Alternaria* themes and variations (27-53). Mycotaxon 37: 79-119.

—— 1995a. *Alternaria* chronology and catalogue raisonné. Part I: 1796-1871. Mycotaxon 55: 1-53.

—— 1995b. *Alternaria* themes and variations (112-144). Mycotaxon 55: 55-163.

—— 1999. *Alternaria* themes and variations (226-235). Classification of citrus pathogens. Mycotaxon 70: 263-323.

—— 2000. *Alternaria* themes and variations (244-286). Species on Solanaceae. Mycotaxon 75: 1-115. (including "An Aside on Lectotypes from Divided Collections.")

Snowden, J. D. 1927. Report of the acting mycologist for the period 10th November, 1925, to the 30th September, 1926. Uganda Protectorate, Ann. Rept. Dept. Agric. Year ended 31st December, 1926. 1926: 30-32.

Spegazzini, C. 1879. Decades Mycologicae Italicae, N. 4-5-6. Sumpt. auct., Conegliano.

Stevenson, J A. 1971. An Account of Fungus Exsiccati Containing Material from the Americas. Beih. Nova Hedwigia, Heft 36. 468 pp. Lehre, J. Cramer.

Tehon, L. R., and E. Daniels. 1925. A note on the brown leaf-spot of alfalfa. Phytopathology 15: 714-719.

Thümen, F.K.A.E.J de. 1877. Herbarium Mycologicum Oeconomicum, Fasc. 11 (n. 501-550). Klosterneuburg.

—— 1878. Mycotheca Universalis, Cent. 10. (n. 901-1000). Klosterneuburg.

—— 1879a. Mycotheca Universalis, Cent.15 (n. 1401-1500). Klosterneuburg.

—— 1879b. Hyphomycetes nonnulli novi Americani. Revue Mycologique 1:58-61.

—— 1879c. Verzeichniss der um Bayreuth in Oberfranken beobachteten Pilze. Ber. Bot. Vereines Landshut 7: 165-212.

—— 1884. Mycotheca Universalis, Cent. 23 (n. 2201-2300). Görz.

United States Department of Agriculture. 1960. Index of Plant Diseases in the United States. Agric. Handbook no. 165. 531 pp.

Weber, G. F. 1930. Gray leaf spot of tomato caused by *Stemphylium*. Phytopathology 20: 513-518.

Willis, J. C. 1973. A Dictionary of the Flowering Plants & Ferns. 8th edition (Student edition 1985). 1245 + lxvi pp.

Wiltshire, S. P. 1938. The original and modern conceptions of *Stemphylium*. Trans. Brit. Mycol. Soc. 21: 211-239.

Wollenweber, H. W. 1932, p. 713, in Sorauer's Handbuch der Pflanzenkrankheiten, ed 5, vol. III(2).

Yamamoto, W. 1960. Synonymous species of *Alternaria* and *Stemphylium* in Japan. Trans. Mycol. Soc. Japan 2: 88-93.

Zhang, T. Y., and M. Z. Gao. 2000. Taxonomic studies of *Alternaria* from China V. New taxa and new records on Malvaceae, Nymphaeaceae and Rosaceae. Mycosystema 19: 454-458.

Zhang, X. G., Y. M. Wu, and T. Y. Zhang. 2003. Taxonomic studies of *Stemphylium* from China. Mycotaxon 80: 247-252.

Zimmermann, A. 1904. Untersuchungen über tropische Pflanzenkrankheiten. Erste Mitteilung. Ber. Land- Forstw. Deutsch-Ostafrika 2: 11-36.

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A NEW WHITE-ROT POLYPORE FROM ITALY

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ABSTRACT: A new polypore species (Basidiomycetes), *Ceriporiopsis guidella,* is described from Northern Italy.

Key words: *Ceriporiopsis*, wood-inhabiting fungus, Polyporales.

INTRODUCTION

It is commonly assumed that the European polypores are well known after hundred years of collecting, at least if compared with other continents. Some areas of Northern Italy have been particularly very well investigated during the last twenty-five years, but still new species are being recorded. This is especially the case for the Reserve of Sasso Fratino (Forlì), which has a rich mycota because the area is isolated and difficult to access. Further, investigations and collecting is restricted for scientific purposes only. More than 700 macrofungi have been recorded so far, among them a high number of very rare species (Bernicchia, 1995). Among these are *Fomitopsis labyrinthica* Bernicchia & Ryvarden (1996) that has its type locality in the area.

One reason for the rich mycota in the reserve, is the absence of anthropogenic activities, at least in the inner part of the area of 60 ha. In certain places there are trees like *Fagus sylvatica, Abies alba, Acer pseudoplatanus, Taxus baccata* and *Ulmus glabra* that are over 300 years old.

During a recent collecting trip, one of us (AB) collected a resupinate polypore for which no suitable name could be found. Repeated examination of the specimens and search in pertinent literature (Gilbertson & Ryvarden 1986-87; Ryvarden & Gilbertson 1993-94; Núñez & Ryvarden 2001) brought no solution to its identity. We finally came to the conclusion that it represents an unknown species, which is described below.

Ceriporiopsis guidella Bernicchia & Ryvarden spec.nova

Basidiomata annua, resupinata, effusa, usque ad 0,8-1 cm spissa, tenera, fragilia sed friabilia et cartilaginea deinde post siccatione.

Systema hypharum monomiticum: hyphae generativae hyalinae, ramosae, fibulatae, 2-3 µm latae, tunicis tenuibus, quae materiam oleaceam continent; cystidioli hyalini, flexuosi, fusiformes. Basidia hyalina, tetrasterigmatica, subglobosa vel plusminusve clavata, 15-

20 x 4-5 µm. Basidiospores hyalinae, non amyloideae, non dextrinoideae, tenuitunicatae, 4-5 x 2.0-2.4 µm (Fig. 1). Cariem albam in ligno producet.

Holotypus: Italia, Parco Nazionale delle Foreste Casentinesi, Riserva Integrale di Sasso Fratino, Rio Cullacce (Forlì), alt. 900-1000 m, in trunco *Acer pseudoplatanus*, 02.X.2002; legit A. Bernicchia, C. Pancaldi et L. Angioloni, coll. 7600 (HUBO: holotypus et isotypus; O: isotypus).

Other specimens examined: collections as the holotypus, Bernicchia (HUBO) 7570, 7541, 7601, from the same locality and substrate.

Etymology: the species is dedicated to the recently deceased friend and entomologist Guido Campadelli.

Basidiocarps annual, resupinate, adnate and widely effused, soft and fleshy when fresh, hard, brittle, cartilaginous, shrinking upon drying. Margin very thin, almost missing. Pore surface with a greasy appearance, the colour ranging from dull yellow to greenish, getting darker upon drying and cracking into a characteristic pattern of small squares.

Pores round to slightly angular, translucent, 4-5 per mm; dissepiments thin, entire, lacerate with age, subiculum almost totally lacking, present only as a thin line, concolorous with the tubes, the latter concolorous with the pore surface, 4-6 mm deep.

Hyphal system monomitic: generative hyphae with clamps at the septa, thin-walled, 2-3 µm in diam; commonly with numerous oil drops, in parts basally inflated, close to the substratum, consistency dense and fragile in dry conditions. Cystidia not seen, but fusoid cystidioles 20-30 µm long and 5-6 µm wide in the basal part, present in well preserved hymenia, which however collapse rapidly on drying.

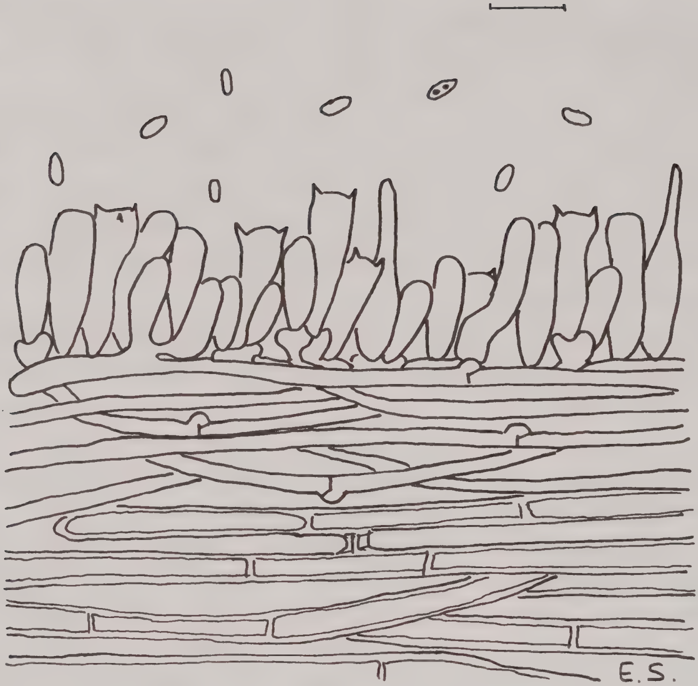

Figure: 1 – Hymenial elements of *Ceriporiopsis guidella*, holotype (drawing by E. Salerni).

Basidia first subglobose, then barrel-shaped and finally clavate, with 4 thin sterigmata and a basal clamp, 15-20 x 4-5 µm.
Basidiospores numerous, thin-walled, smooth, cylindrical, negative in Melzer's' reagent, 4-5 x 2.0 –2.4 µm (Fig. 1).
Substrate. Causing white rot on *Acer pseudoplatanus*.
Remarks: The monomitic hyphal system with clamps at the septa, the lack of cystidia and any reaction in Melzer's reagent, and the white rot, places the new species clearly in *Ceriporiopsis*, which includes species with this combination of characters.
The pore surface cracks characteristically into a deep pattern of squares or angular pieces, giving to it macroscopically a peculiar appearance. Microscopically it may recall *Ceriporiopsis resinascens*, which however

becomes brown with maturity, has a distinct subiculum, larger pores and spores, the latter also being more cylindrical.

With this new species added to the European mycota we felt it would be useful to present a key to the currently accepted European species of *Ceriporiopsis*, and this is given below. For descriptions of the other species included in the key, the readers are referred to Ryvarden & Gilbertson (1993-95).

KEY TO EUROPEAN SPECIES OF *CERIPORIOPSIS*

1. Basidiospores subglobose 2
1. Basidiospores differently shaped 3
2. Basidiocarps soft, white to cream, often with rhizomorphs, basidiospores 2.5-3.5 x 2-2.5 µm **C. mucida**
2. Basidiocarps cream or ochraceous yellowish, no rhizomorphs, basidiospores 3-4 x 2.5-3 µm **C. consobrina**
3. Basidiospores always oblong-ellipsoid, never cylindrical nor subcylindrical 9
3. Basidiospores differently shaped 4
4. Basidiospores allantoid 5
4. Basidiospores subcylindrical to cylindrical 7
5. Pore surface whitish, pores 2-4 per mm **C. subvermispora**
5. Pore surface differently coloured, pores 6-8 per mm 6
6. Pore surface greenish-white, resinous zone above the tubes present, basidiospores up to 1 µm wide **C. pannocincta**
6. Pore surface pale cream-pinkish, resinous zone absent, basidiospores up to 2 µm wide **C. portcrosensis**

7. Pore surface greenish-yellow with a greasy appearance, pores 4-5 per mm, basidiospores 4-5 x 2-2.5 µm, and oil-containing hyphae common **C. guidella**
7. Pore surface with different colour and appearance 8
8. Pore surface at first whitish then pink, pores 4-6 per mm, basidiospores subcylindrical, 4-5 x 1.5-2 µm **C. gilvescens**
8. Pore surface whitish to brownish, pores 3-4 per mm, basidiospores subcylindrical to oblong ellipsoid, 4-5.5 x 2-3 µm **C. resinascens**
9. Pore surface reddish, basidiospores 6-7 x 3-4 µm **C. subrufa**
9. Pore surface differently coloured 10
10. Pores 4-8 per mm 11
10. Pores larger, 1-3 per mm 12
11. Pore surface white, pores 4-6 per mm, basidiospores 3-4 x 1.5-2 µm **C. azorica**
11. Pore surface whitish, then with brown spots, pores 7-8 per mm, basidiospores 2.5-3.5 x 1.5-2 µm **C. jelicii**
12. Pore surface cream then yellowish, pores 2-3 per mm, basidiospores 4-5 x 2.8-3.5 µm, boreal species **C. balaenae**
12. Pore surface white then brown, pores 1-3 per mm, basidiospores 5-7 x 3.5-5 µm, present all over Europe **C. aneirina**

References

Bernicchia, A., 1995 - Aphyllophorales della Riserva Integrale di Sasso Fratino (Forlì). Giorn. Bot. It., 129(3): 837-857.

Bernicchia, A., & Ryvarden, L., 1996 - Two new brown rot polypores from Italy. Mycol. Helv. 8(2): 3-10.

Gilbertson, R.L., & Ryvarden, L., 1986-87 - North American Polypores, Fungiflora, Oslo, Norway.

Núñez, M., & Ryvarden, L., 2001 - East Asian Polypores, Vol. 2, Synopsis Fung. 14:168-522.

Ryvarden, L., & Gilbertson, R.L., 1993-95 – European Polypores, Synopsis Fung. 6-7:1-743.

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AMANITA SIAMENSIS, A NEW SPECIES OF AMANITA FROM THAILAND

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Abstract: *Amanita siamensis*, a new species of section *Amanita*, characterized by a greenish yellow to olivaceous buff pileus with a greyish brown disc, an olivaceous buff stipe, and a bulb at the stipe base, is described and illustrated.

Key words: taxonomy, Basidiomycetes, Agaricales

While studying the diversity of mushrooms of several sites in Northern Thailand, a new, attractive *Amanita* with greenish yellow basidiocarps was found gregariously on the ground in a Fagaceae forest of Doi Suthep-Pui National Park in Chiang Mai Province. It is described in this paper. The color names were coded according to Petersen (1996). The microscopic studies were carried out according to the methods of Yang (1997). The holotype (CMU 4528) is deposited in the fungal herbarium of Department of Biology, Chiang Mai University.

Amanita siamensis Sanmee, Zhu L. Yang, P. Lumyong & S. Lumyong, sp. nov.

Pileus 7.5-9.5 cm diametro, convexus vel plano-convexus, obtuse umbonatus, olivaceo-bubalinus, disco griseobrunneo, margine striata, non appendiculata, reliquiis volvae coactis, farinosis, flocculosis, applanatis, cinnamomeus-bubalinus ornatus; caro alba. Sitpes 9-15 × 1-1.5 cm, subcylindricus, annulatus, bulbo subgloboso, 1.5-2.5 cm diametro, volvae reliquiis floccosis, olivaceo-bubalinis obtecto. Lamellae liberae, albus, confertae. Annulus membranaceus, sursum albus, deorsum melleus, superior, evanidus. Basidia 4-sporigera. Basidiosporae (9.0-) 9.5-11.5 (-13.0) × (5.0-) 5.5-7.0 (-8.0) μm, elongato-ellipsoideae, non-amyloideae, incolorateae, hyalineae. Fibulae absentes. Holotypus: Thailand, Khun Chang-Kian, Doi Suthep-Pui National Park, Chiang Mai Province, 11.VI.2002, R. Sanmee, P. Lumyong, S. Lumyong, R. Kodsueb & W. Chittrong (CMU 4528). Isotypus: HKAS 41153.

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Etymology: *siamensis* refers to the country in which the fungus was collected.

Basidiocarps medium size (fig. 1). **Pileus** 7.5-9.5 cm in diameter, convex to plano-convex, with low broad umbo at disc, greenish yellow to olivaceous buff, with a greyish brown disc; volval remnants farinose or as floccose patches, cinnamon buff; margin striate (0.2-0.4R), slightly reflexed, non appendiculate; trama white, unchanging. **Lamellae** free, white, crowded, farinose at edge; lamellulae truncate to subtruncate. **Stipe** 9-15×1-1.5 cm, subcylindrical or slightly tapering upward, with apex slightly expanded, greenish yellow to olivaceous, densely covered with cinnamon buff, farinose, squamules; trama white; bulb at stipe base subglobose, 1.5-2.5 cm in diameter. **Annulus** membranous, easily broken during expansion of pileus, upper surface white with fine subradial striations, lower surface cinnamon buff, with edge cinnamon buff viewed from above. **Color of spore print** white.

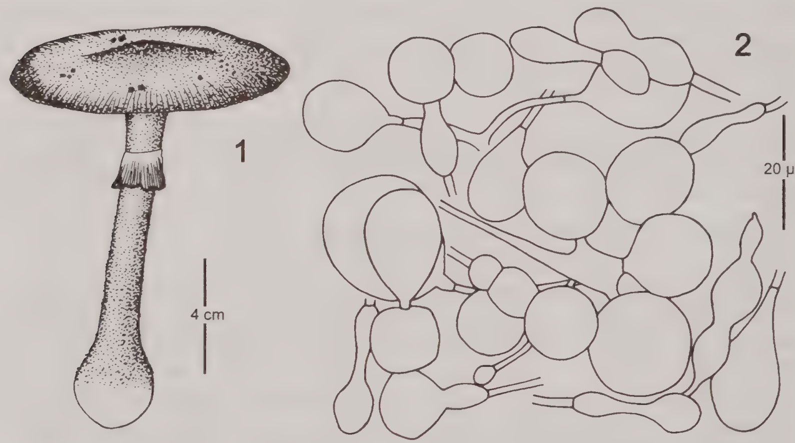

Fig. 1-2: *Amanita siamensis* (holotype: CMU 4528).

1. Basidiocarp; 2. Volval remnants from pileal surface.

Lamella trama bilateral. **Mediostratum** 25-40 μm wide. **Lateral stratum** consisting of long ellipsoid and fusiform cells; inflated cells, intercalary, with 2-3 chains, 10-15 μm wide. **Subhymenium** (fig. 3) 30-40 μm thick, with 2-3 layers of pyriform to broadly clavate cells, 10-20 × 7-13 μm. **Basidia** (fig. 3) 36-48 × 9.5-14.5 μm, clavate, 4-spored; sterigmata 4-7.5 (-9.5) μm long; basal septa without clamps. **Basidiospores** (fig. 4) [60/2/1] (9.0-) 9.5-11.5 (-13.0) × (5.0-) 5.5-7.0 (-8.0) μm [Q=(1.38-) 1.53-1.88 (-1.93), **Q**=1.62±0.15], elongate, sometimes ellipsoid, inamyloid, colorless, hyaline, thin-walled, smooth; apiculus small. **Lamella edge** sterile, consisting of abundant inflated cells, globose to subglobose (15-30 μm), sphaeropedunculate (25-30 × 20-25 μm) to pyriform (20-35 × 15-30 μm), rarely broadly clavate (20-40 × 15-30 μm), single and terminal or in chains of 2-5, thin-walled, colorless, hyaline. **Pileipellis** 60-80 μm thick, hardly gelatinized, composed of subradially arranged, 3-6 µm wide hyphae with brownish vacuolar pigments. **Volval remnants** (fig. 2) on pileus comprising irregularly arranged elements: inflated cells fairly abundant to abundant, globose, subglobose, to ovoid (9-18 µm) or sphaeropedunculate (20-25 × 12-18 µm), sometimes doliform to sublageniform (6-8 × 20-22 µm), or pyriform to broadly clavate (16-24 × 10-12 µm), single and terminal, sometimes in chains of 2-3, with yellowish to brownish vacuolar pigments, thin-walled; volva remnants on the stipe base composed of irregularly arranged elements: filamentous hyphae 2-5 µm wide, more abundant than those of volval remnants on pileus, almost colorless, some brownish; inflated cells globose (20-22 µm), subglobose (18-24 × 17-23 µm), ovoid (20-26 × 15-20 µm) to sphaeropedunculate (18-20 × 25-34 µm), rarely pyriform (15-18 × 29-34 µm). **Stipe trama** dominately consisting of longitudinally arranged, long clavate, terminal cells, 100-360 × 20-35 µm, mixed with 2-8 µm wide hyphae (scattered in interior, fairly abundant on stipe surface). Annulus not found in the studied material.

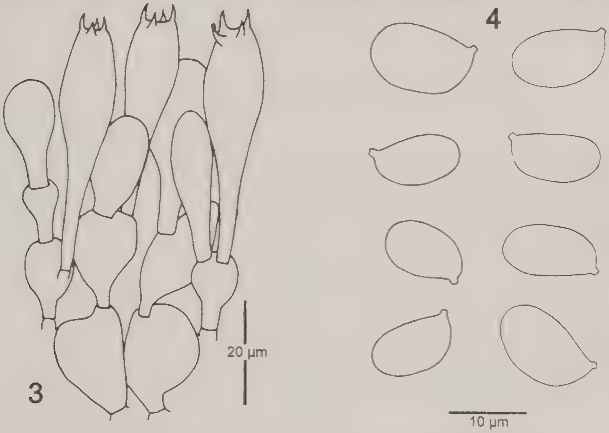

Fig. 3-4 *Amanita siamensis* (holotype: CMU 4528).
3. Hymenium and subhymenium; 4. Basidiospores.

Specimen examined: Thailand, Khun Chang-Kian, Doi Suthep-Pui National Park, Chiang Mai Province, 11.VI.2002, R. Sanmee, P. Lumyong, S. Lumyong, R. Kodsueb & W. Chittrong (CMU 4528, Holotype; HKAS 41153, Isotype).

Habitat and distribution: Gregarious on ground in a forest dominated by fagaceous trees. Presently only known from the type locality.

Observations: *Amanita siamensis* belongs in *Amanita* subgenus *Amanita* section *Amanita*. It is characterised by its medium-sized basidiocarps with a greenish yellow to olivaceous buff color pileus covered with cinnamon buff, farinose or floccose volval remnants, a stipe densely covered with cinnamon buff, farinose squamules, a membranous but easily broken annulus, a bulb on the base of the stipe, elongate, inamyloid spores, and clampless bases of basidia. *Amanita siamensis* may be related to *A. rufoferruginea* Hongo, *A. xerocybe* Bas, *A.*

roseitincta (Murrill) Murrill, *A. guzmanii* Cifuentes, Villegas et G. Santiago and *A. levistriata* D. T. Jenkins. However, *A. rufoferruginea*, originally described from Japan, has yellowish brown colored basidiocarps with reddish brown remnants on pileus, and globose to subglobose basidiospores (Hongo, 1966; Imazeki *et al.*, 1988; Imazeki & Hongo, 1995; Yang, 1997). *Amanita xerocybe,* known from South America, has ochraceous colored basidiocarps, at centre brownish ochraceous yellow to ochraceous brown, and globose to subglobose basidiospores (Bas, 1978; Simmons *et al.*, 2002); *Amanita roseitincta*, described from North America, has salmon coloured pileus, white stipe and annulus tinged with salmon, salmon colored volval remnants (Jenkins, 1979), and the spores are shorter (Tulloss, unpublished); *Amanita guzmanii*, described from Mexico, has cream colored basidiocarps with powdery gloden-brown veil, large squamulose truncate-pyramidal warts on pileus, stipe bulbose subglobose, and ellipsoid to long ellipsoid spores (Santiago *et al.*, 1984); *Amanita levistriata*, described from North America, has small fruitbody size, a golden-yellow pileus with floccose patches of universal veil, and globose to subglobose basidiospores (Jenkins, 1988).

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LITERATURE CITED

Bas, C. (1978): Studies in *Amanita* – I. Some species from Amazonia. Persoonia 10: 1-22.

Hongo, T. (1966): Notes on Japanese larger fungi (18). Journ. Jap. Bot. 41: 165-172.

Imazeki, R., Y. Otani & T. Hongo (1988): Fungi of Japan. Yama-kei Publishers Co., Ltd., Tokyo (in Japanese).

Imazeki, R. & T. Hongo (1995): Colored illustrations of mushrooms of Japan. Vol. 1. Hoikusha Publishing Co., Ltd., Osaka (in Japanese).

Jenkins, D.T. (1979): A study of *Amanita* types III. Taxa described by W. A. Murrill. Mycotaxon 10: 175-200.

Jenkins, D.T. (1988): A new species of *Amanita* from North America: *Amanita levistriata*. Mycotaxon 32: 415-419.

Petersen, J.H. (1996): The Danish Mycological Society's Colour-Chart.

Santiago, G., J. Cifuentes & M. Villegas (1984): Contribucion al conocimiento del genero *Amanita* subgenero *Amanita* en M_xico. Bol. Soc. Mex. Micol. 19: 93-105.

Simmons, C., T. Henkel & C. Bas (2002): The genus *Amanita* in the Pakaraima mountains of Guyana. Persoonia 17: 563-582.

Yang, Z.L. (1997): Die *Amanita*-Arten von S_dwestchina. Biblioth. Mycol. 170: 1-240.

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THE GENUS MYCORRHAPHIUM IN AFRICA

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Abstract

Mycorrhaphium africanum is described as new and a key to the genus in Africa is provided.

Key words: Hydnoid fungi, *Climacodon*

Introduction.

The genus *Mycorrhaphium* was described by Maas Geesteranus (1962) with *Hydnum adustum* Schw. as type species. The genus is characterized by a stipitate basidiocarp with a hydnoid hymenophore, a dimitic hyphal system with skeletal hyphae restricted to the trama in the spines, absence of cystidia and smooth, hyaline basidiospores without a reaction in Melzer´s reagent. The generative hyphae may have clamps or simple septa.

Most species of *Mycorrhaphium* have small basidiocarps, rarely above 5 cm in diameter. *Climacocystis* P. Karsten has large compound basidiocarps with spines and the hyphal system is monomitic and large cystidia are present. Thus, we feel that the two genera are not related.

Recently one of us (D.C.M) collected a stipitate dimitic hydnoid species in the Dja biosphere reserve in Cameroon, clearly belonging in *Mycorrhaphium*. The key to all known species of the genus as given by Ryvarden (1989) was consulted, but gave no clue to the identity of the African collection. Thus, we came to the conclusion that it represents a new species, which is described below.

Beeli (1926) described a stipitate red hydnoid species from Zaïre as *Hydnum sanguineum*, which later was transferred to *Donkia* Pilat by Maas Geesteranus (1967) who later (1970) provided a French description with a coloured illustration. *Donkia* is today treated as a taxonomic synonym of *Climacodon* (Maas Geesteranus 1971:131). Species of this genus are all characterized by a monomitic hyphal system and presence of cystidia. Thus it should be easy to separate *Climacodon sanguineus* (Beeli) Maas Geest. from the species described below in spite of the macroscopical similarities between the species.

Mycorrhaphium Maas Geesteranus
Persoonia 2:394, 1962.
Basidiocarps centrally to laterally stipitate, lower side densely hydnoid, hyphal system dimitic with generative and skeletal hyphae, gloeocystidia present or absent,

basidiospores smooth, thin-walled, hyaline and without reaction in Melzer's reagent, widespread genus, but not common.
Type species: *Hydnum adustum* Schw.

Key to African species of *Mycorrhaphium*
1. Basidiocarp citric yellow **M. citrinum**
1. Basidiocarp white, ochraceous to brown **M. africanum**

Mycorrhaphium africanum Mossebo & Ryvarden nov. sp.
Basidioma usque ad 7.5 cm latum, subdepressus, laevis, glabrous, pallide brunneus, stipes 3-5 cm x 3-6 mm, aculei 1-3 mm longi, albidus vel ochraceous, systema hypharum dimiticum, hyphae skeletales crassitunicatae, hyphae generatoriae fibulatae, cystidia absunt, sporae cylindricae, leves, hyalinae, non-amyloideae 4.5-5 x 2 μm.
Holotype: Cameroon, Dja Biosphere reserve, 7. April 2001, on dead hard wood branches, D. C. Mossebo, 292A, YA, isotype in O.
Basidiocarp centrally to laterally stipitate. pileus 4 -7.5 cm in diameter, funnel shaped, sometimes convex with flattened margins, pileus first whitish, then pale brown to reddish brown with whitish to pinkish spots, smooth, glabrous and in dry condition distinctly radially veined, margin flat and wavy when fresh, incised in the outer parts when dry due to slight contracting, lower side densely hydnoid, individual spines first white then pale brown when dry, up to 3 mm long, stipe glabrous, whitish becoming ochre when dry, 3-5 cm long, 3-6 mm in diameter, slightly widened towards the pileus, solid, context up to 200 μm thick, white becoming dense and pale brown when dry.

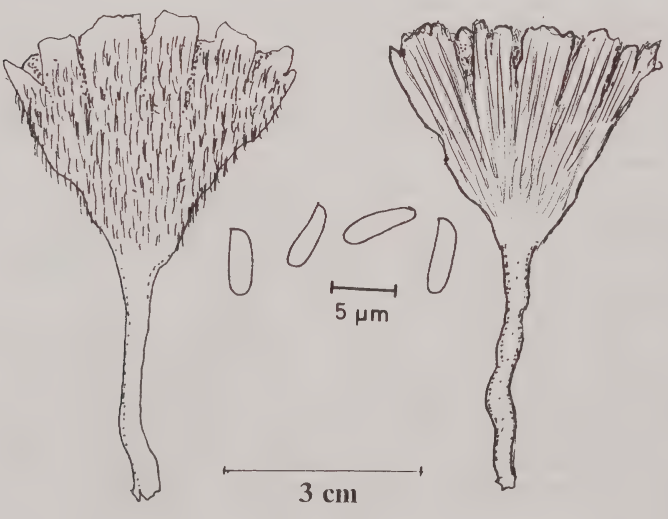

Fig. 1. *Mycorrhaphium africanum*. Basidiocarp from lower and upper side respectively, and basidiospores. From the isotype.

Hyphal system dimitic, skeletal hyphae confined to the trama of the spines, hyaline and thick-walled, 3-5 µm diam, more or less parallel, generative hyphae with clamps, thin-walled and strongly branched in the subhymenium, 2-4 µm wide, in the context of pileus and stipe distinctly thick-walled, very sparingly branched and with rather scattered clamps, 3-5 µm diam.
Cystidia not seen, cystidiols present among the basidia, pointed, smooth, thin-walled, 10-15 x 4-5 µm.
Basidia clavate, 12-14 x 4-5 µm with 4 sterigmata and a basal clamp.
Basidiospores cylindrical, smooth, hyaline and non amyloid, 4.5-5 x 2 μm.
Substrate: On the ground among litter.
Distribution. Known only from Cameroon.
Remarks. The species is easy to recognize by its stipitate brownish basidiocarp.

Mycorrhaphium citrinum Ryvarden.
Mem. NY Bot. Garden 49:346, 1994.
Basidiocarp centrally to laterally stipitate. pileus 1-2.5 cm wide, circular to fan-shaped or semicircular, slightly lobed to deeply incised in one specimen, flat to centrally depressed. citric yellow to pale yellowish-brown, glabrous, slightly concentrically zonate, slightly wrinkled from the centre of the pileus, margin deflexed in dry condition, flat and wavy when fresh, stipe glabrous, bright citric yellow, 1.5-2.5 mm diam and with rhizomorphs from the base, spines densely crowded, pale citric yellow, 1-3 mm long, stipe slightly expanding towards the pileus, centrally to laterally attached, in one specimen split in the top as if three individual pilei have become fused, context white to pale citric yellow in stipe and pileus.
Hyphal system dimitic, skeletal hyphae confined to the trama of the spines, hyaline and thick-walled. 3-5 µm diam, more or less parallel, generative hyphae with clamps, thin-walled and strongly branched in the subhymenium, 2-4 µm wide, in the context of pileus and stipe distinctly thick-walled, very sparingly branched and with rather scattered clamps, 3-5 µm diam.
Cystidia not seen, cystidiols present among the basidia, pointed, smooth, thin-walled, 10-15 x 4-5 µm.
Basidia clavate, 12-15 x 4-5 µm with 4 sterigmata and a basal clamp.
Basidiospores subcylindrical to oblong ellipsoid smooth, hyaline and with a small oil drop, non amyloid, 3-*3.5* x 2-2.5 µm.
Substrate: On the ground among litter.
Distribution. Known only from Zambia.
Remarks. The species is easy to recognize by its stipitate, bright citric yellow hydnoid basidiocarp.

References

Beeli, M. 1926: Contribution nouvelle à la flore mycologique du Congo. Bull. Soc. Bot. Belg. 58: 190-210.

Maas Geesteranus, R. A. 1967: Quelques champignons hydnoides du Congo. Bull. Jard. Bot. Nat. Belg. 37:77-107.

Maas Geesteranus, R. A. 1970: Hydnum s. l., Flore Icon. Champ Congo, Fasc. 17 : 325-331.

Maas Geesteranus, R. A. 1971: Hydnaceous fungi of the Eastern old world. Verhand. Kon. Nederl. Akad. Wetensch. Afd. Naturk. 2 reeks, deel 60, no 3:1-176.

Ryvarden, L. 1989: *Mycorrhaphium cintrinum* sp. nov. (Basidiomycetes, Aphyllophorales). Mem. New York Bot. Garden 49 : 344-347.

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IMPUDENTIA CRIOCERIS, A NEW GENUS AND SPECIES OF DEMATIACEOUS HYPHOMYCETES ON TWO CRIOCERIS INSECTS IN QUÉBEC, CANADA

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ABSTRACT

Impudentia crioceris gen. et sp. nov., a new dematiaceous hyphomycetous fungus (mitosporic fungi) is described and illustrated. It occurs on two *Crioceris* species: *Crioceris asparagi* and *C. duodecimpunctata* (Coleoptera : Chrysomelidae), insects from asparagus fields in Québec, Canada,. It is unique in producing two types of dark, aseptate macroconidia with an elongated germ slit holoblastically from dark brown, cylindrical conidiogenous cells or from undifferentiated cells on brownish hyphae or stromata. *Impudentia* is compared with *Arthrinium, Gilmaniella, Mammaria, Chalara, Wardomyces* and *Yinmingella.*

Keywords : mitosporic fungi, *Asparagus*

RÉSUMÉ

Impudentia crioceris gen. et sp. nov. est un champignon dematiacé (Hyphomycetes) qui a été décrit et illustré. Il infecte deux espèces d'insecte du genre *Crioceris*: C *asparagi* et *C. duodecimpunctata* (Coleoptera : Chrysomelidae) récotés dans une plantation d'asperge au Québec, Canada. Il est unique en ce qu'il produit des deux types des conidies holobalstiques, foncées et aseptées, avec rupture germinative, à partir de cellules conidiogènes cylindriques, brun-foncé, développés sur les cellules conidiogènes ou sur les cellules non-différentiées sur des hyphes ou des stromas brunâtres. *Impudentia* est également comparé avec les *Arthrinium, Gilmaniella*, *Mammaria*, *Chalara*, *Wardomyces* and *Yinmingella*.

Mots clés: *Deutéromycètes, Asparagus*

INTRODUCTION

During an ecological study of the fungal flora inhabiting two insects *Crioceris asparagi* (Linnaeus) and *C. duodecimpunctata* (Linnaeus) (Coleoptera : Chrysomelidae) in commercial asparagus fields in Québec, Canada, an interesting dematiaceous microfungus was recorded several times. The most distinctive feature of this isolate is the production of dematiaceous multiform conidia, with a longitudinal germ slit, directly on conidiogenous cells or from undifferentiated cells of brownish hyphae or stromata. Although the conidiogenous cells are cylindrical, they are not "phialides" sensu Minter et al. (1983) and do not proliferate (Goh et al. 1998). The combination of these morphological characters excludes this fungus from any of the existing hyphomicetous fungal genera. We therefore introduce *Impudentia* as a new genus to accommodate this unusual and unique hyphomycete.

MATERIAL AND METHODS

In July 2001, from two species of *Crioceris* (*C. asparagi* and *C. duodecimpunctata*), loc. Assomption (Québec), we isolated an unknown dematiaceous fungal species on PDA plates [2% potato-dextrose agar supplemented with Streptomycin sulphate (Sigma, St-Louis, MO, USA, 100mg/l) and Neomycin sulphate (Sigma, St-Louis, MO, USA,12 mg/l)] incubated 1 week in the darkness at 28°C (_1). For microscopic examinations, fertile fungal structures were obtained on PDA plates after 1 week of growth. Fifty stromata structures, one hundred conidiogenous cells and two hundred conidia were measured. Observations, photographs, and measurements of conidiogenous cells and conidia were made in water and lactophenol 0.1% cotton blue. Radial growth was measured in two axes every 24 h over a one week period, using plates incubated at 28°C (_1) in darkness. Growth rates are averages of three replicates.

TAXONOMY

Impudentia VUJANOVIC, gen. nov. FIGURE 1

ETIMOLOGY: Impudentia, ae. f. – Impudent, shamelessness (Lat.)

Ad fungos conidiales, Mitosporic Fungi, pertinens. Coloniae in agaro 'potato-dextrosum' effusae, primum albae, pallide olivaceo-grisea. Mycelium superficiale et partim in substrato immersum, ex hyphis ramosis et anastomosantibus. Setae nullae. Hyphopodia et synanamorph absentia. Stromata evoluta, hemisphaerica, pallide brunea, pseudoparenchymatica. Conidiophora absencia. Cellulae conidiogenae discretae, determinateae, mono- vel polyblasticae, integratae, hyalinae, modice brunea vel atrae, cylindrice vel clavatae ad doliiformes, apicales, laterales vel intercalares, crassitunicatae, leaves. Conidia holoblastica, solitaria, multiformes, dematiacea, aseptata, terminalia vel sympodiallia, porus germinationis longitudinalis, conidiorum secesio schizolitica.

Mitosporic Fungi, Hyphomycetes. *Colonies,* effuse, at first white, turning pale olivaceous-grey. *Mycelium* superficial, partly immersed, composed of branched and anastomosing hyphae. *Stroma* brownish composed of pseudoparenchymatous cells. *Setae, hyphopodia* and "phialidic" *synanamorph* absent. This genus is developmentally very plastic. *Conidiophores* absent or replaced by unbranched and rarely branched, straight or flexuous, brown or hyaline, smooth, vegetative hyphae. *Conidiogenous cells* monoblastic but sometimes polyblastic, integrated, terminal and intercalary or discrete, cylindrical to clavate or doliiform. *Conidia* holoblastic, solitary, multiformis, dematiaceous, with longitudinal germ slit, terminal or sympodial, mode of secession schizolytic.

SPECIES TYPICA: *Impudentia crioceris* gen. et sp. nov. VUJANOVIC

Impudentia crioceris VUJANOVIC, sp. nov. FIGURES 2-9

ETYMOLOGY: crioceris, referring to the insect name (Latin)

Coloniae super substratum 'potato-dextrosum' tenues, ad 0.2 cm in una die 28°C crescents. Hyphae hyalinae, septis, 1.5-3 µm crassis. Stromata hemisphaerica, 15-45 µm lata, 10-30 µm alta, pallide brunea, ex cellulis intricatis, crassitunicatis, 2-6 µm latis, compositum. Conidiophora absencia. Cellulae conidiogenae crassitunicatae, laeves, hyalinae, modice brunea vel atrae, cylindrice vel clavatae ad doliiformes, apicales, laterales vel intercalares, aseptatae, mono- or polyblasticae, 2-14 x 1-3.5 µm. Conidia holoblastica, solitaria, multiformes, dematiacea, aseptata, terminalia vel sympodiallia, porus germinationis longitudinalis, 5-11.5 x 4.3-5 µm, conidiorum secesio schizolitica.

Colonies on potato-dextrose effuse, white to gray, velvety, punctiform, growing rapidly, reaching a diameter of 2 cm in 1 day at 28°, or 3 mm in 1 day at 4°C in darkness. *Mycelium* partly superficial and partly immersed in substratum, composed of hyaline, smooth, 1.5-3 µm wide, branched hyphae. *Stroma* hemispherical, 15-45 µm long, 10-30 µm wide, developed from pale to medium brown interwoven, 2-6 µm wide, smooth hyphae. This genus is developmentally very plastic (sensu Minter 1985). *Conidiophores* absent.

Conidiogenous cells, terminal, lateral or intercalary, from undifferentiated or conidiophorous hyphae, smooth, variable in shape, size and color; the conidiogenous cell is brown to subhyaline, aseptate, mono- or polyblastic, unbranched or branched, cylindrical to clavate or doliiform, straight or flexuous, 4-13.8 x 1.2-3.4 µm; the conidiogenous cell is hyaline, septate, mono- or polyblastic, flexuous, without "conidiophore mother cell", cylindrical, 2-12 x 1-2 µm.

1

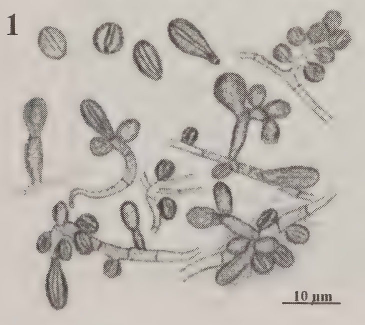
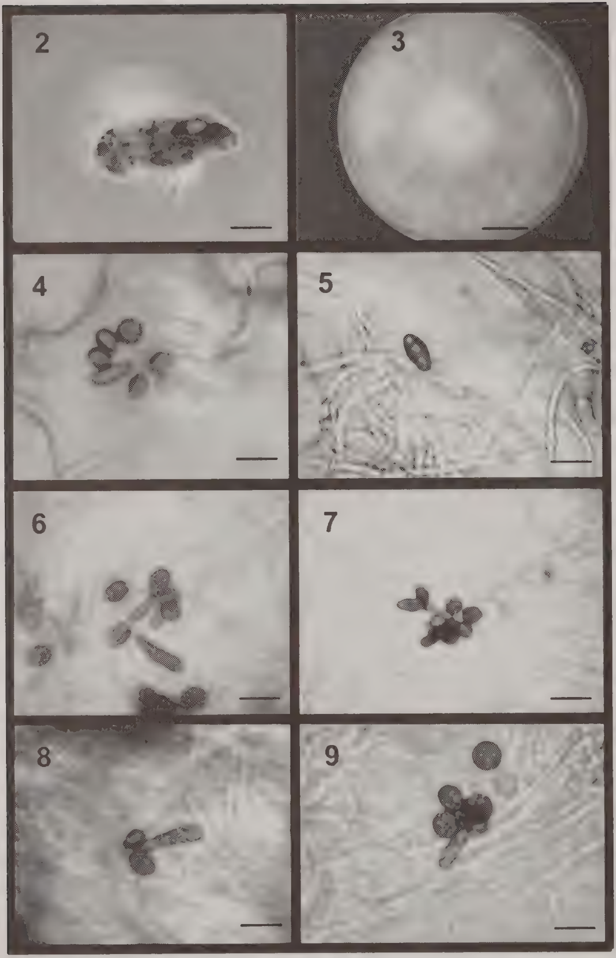


Figure 1. Microscopic cultural features *of Impudentia cioceris* showing developmental plasticity.



Figures 2-9. Light micrographs of *Impudentia crioceris* from holotype (MT-IC08) : 2. Fungal colony from the insect host (*Crioceris asparagi*) (bar = 1000 µm); 3. Macroscopic view of colony on PDA 4. Brown stromata bearing conidia (bar = 50 µm); 5-9. Conidiogenous cells and developing conidia (bar = 10 µm).

Conidia solitary, rarely two in a chain, dematiaceous, aseptate, truncate at the base, smooth, longitudinal germ slit, terminal or sympodial but can also be produced intercalary on vegetative hyphae, 5-11.5 x 4.3-5 μm; if terminal usually longer and pyriform with more or less protuberant stalk cell; if lateral round or lenticular (lenticularia lat.) in form and without stalk; secession by schizolysis.

Teleomorph: Unknown.

HOLOTYPUS : Canada, Québec, Assomption, on the insect *Crioceris asparagi*. 2 July 2001, Gérard Mailloux, MT-IC08 (Herbarium: Marie-Victorin).

DISCUSSION

Impudentia is a dematiaceous hyphomycete genus with a curious combination of developmental characteristics which makes it appear strikingly different from any other similar mitosporic fungi that have conidia with longitudinal splits. This genus possesses a unique combination of conidial, conidiogenous, conidiophore and structural characters (Carmichael et al. 1980; Kiffer and Morelet M. 1997). These include (i) sporulation that occurs on brown individual hypha or hemispherical stroma (ii) absence of distinct conidiophores, where conidia are produced from discrete, cylindrical, flat topped, darkly pigmented, nonproliferating conidiogenous cells or sometimes from hyaline conidiogenous cells, septate flexuous, without "conidiophore mother cells"; (iii) holoblastic, unicellular, aseptate, dark, conidia with longitudinal germ slit and (iv) schizolytic conidial secession.

Only a few hyphomycetes such as *Arthrinium* Kunze, *Gilmaniella* Barron, *Mammaria* Cesati, *Chalara* (Corda) Rabenhorst and *Wardomyces* F. T. Brooks & Hansford produce unicellular dark conidia with germ slits that are comparable to those of *Impudentia*. Species of *Arthrinium* differ from *Impudentia* in having enteroblastic proliferation, basauxic conidiophores, which arise from structures, apparently unique to this genus, called "conidiophore mother cells" (Hughes 1953, Ellis 1971, 1976). *Gilmaniella* species have no stroma (Ellis 1971) and produce conidia bearing single (Sivanesan and Sutton 1985) or numerous circular germination pores (Moustafa and Ezz-Eldin 1989). *Mammaria* and *Wardomyces* produce a dark conidial state with similar germ slits but differ from *Impudentia* by the production of a phialidic synanamorph with hyaline conidia (Ellis 1971). Similar developmental plasticity in a dark conidial stage has been observed also in the *Chalara* anamorph state of *Ceratocystis fimbriata* (Ellis & Halst.) Sacc., *C. paradoxa* (Dade) C. Moreau and *C. radicicola* (Bliss) C. Moreau. But these fungi show a free variation between holoblastic and enteroblastic mode of conidia development and both hyaline and dark conidial stages (Minter 1985). Recently, Goh et al. (1998) described the genus *Yinmingella* Goh, Tsui & Hyde which has holoblastic dematiaceous conidia seceding by schizolysis that are comparable to those of *Impudentia*. It also has conidiophores that are absent or reduced to flask-shaped conidiogenous cells. What makes this genus different from *Impudentia* is the characteristic mitriform conidia, without germ slits, forming in chains on well-developed sporodochial conidiomata.

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LITERATURE CITED

Carmichael, J.W., Kendrick, W.B., Conners, I.L. and Sigler, L. 1980. Genera of *Hyphomycetes*. University of Alberta Press, Edmonton, Alberta, Canada.

Ellis, M.B. 1971. Dematiaceous *Hyphomycetes*. - CMI, Kew, Surrey, London. England.

Ellis, M.B. 1976. More dematiaceous *Hyphomycetes*. - CMI, Kew, Surrey, London. England.

Goh, T.K., Tsui, K.M., Hyde, K.D. 1997. *Yinmingella mitriformis* gen. et sp. nov., a new sporodochial hyphomycete from submerged wood in Hong Kong. Can. J. Bot. 76: 1693-1697.

Hughes, S.J. 1953. Conidiophores, conidia and classification. Can. J. Bot. 31: 577-659.

Kiffer, E., Morelet, M. 1997. The Deuteromycetes. Mitosporic Fingi – Classification and Generic Key. Sciences Publishers Inc., Enfield, NH, USA.

Minter, D.W., Sutton, B.C., Brady, B.L. 1983. What are phialides anyway? Trans. Br. Mycol. Soc. 81: 109-120.

Minter, D.W. 1985. A re-appraisal of the relationships between *Arthrinium* and other hyphomycetes. Proc. Indian Acad. Sci. (Plant Sci.) 94: 281-308.

Moustafa, A.F., Ezz-Eldin, E.K. 1989. *Gilmaniella multiporosa*, a new dematiaceous hyphomycete from Egyptian soils. Mycol. Res. 92: 502-505.

Sivanesan, A., Sutton, B.C. 1985. Microfungi on *Xanthorrhoea*. Trans. Br. Mycol. Soc. 85: 239-255.

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A RECORD OF MUSCODOR ALBUS, AN ENDOPHYTE FROM MYRISTICA FRAGRANS IN THAILAND

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ABSTRACT

Isolate MFC2 is identified as *Muscodor albus*, an endophyte residing in the cambium of *Myristica fragrans*, a nutmeg tree in Thailand. This strain is characterized by the production of a whitish felt-like mycelium on PDA. It develops no fruiting structures on water agar containing sterile pieces of the host plants and other media. The MFC2 isolate is related to the family of *Xylariaceae* based upon 92% similarity of ITS1, 5.8S rDNA, and ITS2 sequences of *Xylaria arbuscula* and *Hypoxylon fragiforme*. High similarities of ITS1, 5.8S rDNA, and ITS2 sequences showed that the isolate MFC2 is taxonomically related to *M. albus*, *M. roseus*, and *M. vitigenus* by virtue of 99%, 99% and 92% homology, respectively. For GC/MS volatile fingerprinting, *M. albus* isolate MFC2 produces volatile compounds which are some of the major components of the volatiles of *M. albus, i.e.*, propanoic acid and ethanol. *M. albus*, *M. roseus* and *M. vitigenus* each primarily produce naphthalene either exclusively or in combination with naphthalene derivatives while MFC2 mainly produces bulnesene, ledol, (-)-globulol and a number of other azulene derivatives. Because of its DNA homologies, the whitish nature of the mycelium and some similarities in the volatile compounds that are produced, the organism is recorded here as the MFC2 strain of *M. albus*.

Keywords: *Xylaria*, Mycelia Sterilia, ITS and 5.8S rDNA, azulene derivatives, (-)-globulol, ledol

INTRODUCTION

Due to the extreme diversity of endophytic microbes in rainforest plants, it has been of interest to isolate and characterize some of these organisms, especially *Muscodor* spp. which have the ability to produce gaseous volatiles that act as efficient antimicrobials of plant pathogens as well as human pathogens (Strobel et al., 2001). Characteristically, members of this genus do not possess fruiting structures or spores and have been characterized via molecular biological techniques. Thus, binomials have been established for these fungi using the molecular methods of Phylogenetic Character Mapping; 18S rDNA plus ITS1, 5.8S rDNA, and ITS2 sequences were determined using PCR techniques and then submitted to GenBank for comparison to other fungal sequences (Bruns et al., 1991; Reynolds and Taylor 1993; Mitchell et al., 1995; Guarro et al., 1999; Taylor et al., 1999). Ultimately, it was shown that these isolates were related but not identical to *Xylaria*, and were related to each other at the genus level (Worapong et al., 2001a&b).

One of these fungi, *Muscodor albus*, was isolated from the internal tissues of a cinnamon tree branch, *Cinnamomum zeylanicum*, growing in Honduras (Worapong et al., 2001a). Another two isolates of a related species, *Muscodor roseus* (Worapong et al., 2001b), were acquired from two separate plant species native to Australia, *Erythophelum chlorostachys* and *Grevillea pteridifolia*. The latest one that has been isolated is *Muscodor vitigenus* obtained from a flowering vine, *Paullinia paullinioides*, growing in the Peruvian rainforest (Daisy et al., 2002a). All *Muscodor* spp. share the features of growing slowly, having a felt-like mycelium, having a distinctive odor, and do not have detrimental effects on tested plants. However, there are cultural, chemical, and molecular differences between them. Gas chromatography and mass spectroscopy (GC/MS) helped to identify different active compounds produced by all three species, *Muscodor albus*, *Muscodor roseus* and *Muscodor vitigenus* (Strobel et al., 2001 and Daisy et al., 2002b). Naphthalene derivatives are produced by *Muscodor albus* while *Muscodor vitigenus* produces mostly pure naphthalene, as the most prominent volatile substance (Daisy et al., 2002b).

Interestingly, we isolated another volatile substance producing endophyte, designated MFC2. It was isolated from *Myristica fragrans* Houtt. (Myristicaceae), a nutmeg herb in the Siri Ruckhachati Medicinal Plant Garden, Thailand. *Myristica fragrans* is well known as a tropical nutmeg spice which is the dried seed of the plant. Its sister-spice mace is the dried aril surrounding the shell enclosing the seed. Moreover, *Myristica fragrans* alone contains enough of an aromatic essential oil to be used as an ointment to relieve decongestion and muscle aches (Harborne et al., 1999). *Myristica fragrans* has been used as a fire wood in funeral cremation in Thailand for many years. The isolate MFC2 culture exhibits many of the characteristics common to the existing *Muscodor* isolates, specifically a lack of fruiting structures in culture and lack of spore production. Thus, the intent of this report is to show that isolate MFC2 has enough molecular and structural relatedness to *M. albus* to be considered another strain of this fungus.

MATERIALS AND METHODS

Fungal Isolation

The healthy twigs of *Myristica fragrans* (Houtt.) were taken from the Siri Rukhachati Medicinal Plant Garden, Salaya campus, Mahidol University, Nakornprathom, Thailand. They were about 15.0 cm long and 1.0 cm in diameter. The twig pieces were cut 1.0 cm and thoroughly treated with 70% ethanol. The outer bark was removed with a scalpel. Small pieces of inner bark and whitish cambium were aseptically removed and placed on water agar. Pure fungal cultures were obtained by cutting hyphal tips after incubation for a few days. Hyphal tips of developing isolates designated –MFC2 were aseptically removed and placed on potato dextrose agar (PDA) for five days. After that, fungal colonies were transferred to water agar with sterile Thai cinnamon leaves (0.5x0.5 cm) to encourage spore production.

Scanning Electron Microscopy

Scanning electron microscopy was performed on isolate MFC2 by placing agar pieces as well as host plant pieces supporting fungal growth into distilled water with Triton X 100, a wetting agent, and aspirated for 5 min (Strobel et al., 1996). The fungal preparation was then placed in 2% gluteraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2-7.4) and left overnight. The next day they were washed in six 15 min changes in water buffer, followed by three 15 min changes in 10% ethanol, four 15 min changes in 30% ethanol, five 15 min changes in 50% ethanol, and then they were left to sit in 70% ethanol for two days. They were then rinsed in five-15 min. changes in 100% ethanol. The dehydration process was executed slowly to avoid hyphal shriveling which is associated with rapid dehydration. Ultimately, the fungal material was critically point dried, gold sputter coated, and examined with a JEOL 6100 scanning electron microscope (SEM).

Fungal Growth and Storage

Isolate MFC2 was grown on a wide variety of media to achieve maximum maturation and production of secondary metabolites. This assortment included PDA, Tryptic Soy Broth Agar (TSBA), Corn Meal Agar (CMA), Malt Agar (MA), and water agar (WA) (Oxoid Ltd., Basingstoke, Hampshire, England). Customized media were also prepared including natural potato dextrose agar (PDAN) and V-8 agar. The PDAN was made with 10 grams of potato starch, 15 grams of sucrose, 15 grams of agar, and 1 liter of distilled water. The V-8 agar was made with 88 ml of V-8 juice, 1 gram of calcium carbonate, 10 grams of agar, and 1 liter of distilled water. The fungus was also inoculated onto Petri plates each on WA, PDA, or PDAN containing bark pieces from *M. fragrans* as well as sterile pieces of banana leaves (*Musa* ABB group (triploid) cultivar. “Namwaa”, Musaceae) in order to encourage spore production.

The pure culture of MFC2 was preserved using filter paper methods (Worapong et al., 2002b). The fungus was also grown on PDA for 14 days and cut into small agar bits, placed in sterile distilled water, and stored at 4°C. Finally, the fungus was grown on PDA until hyphal growth was observed and then sterile bark pieces of *Myristica fragrans* were placed on top of the growth. After 14 days the plant pieces were covered with the fungal growth and they were placed in 15% glycerol and stored at both 4°C and –70°C. In each method, fungal viability was determined by placing the hyphal fragments onto PDA and inspecting for growth after 3-4 days. Maintenance of fungal gas-production was determined by analyzing volatiles produced by the fungus using GC/MS procedures (Strobel et al., 2001).

Fungal DNA Isolation and Amplification of Internally Transcribed Space (ITS) and 5.8S rDNA Sequences.

For DNA isolation, MFC2 was grown on PDA in a 9 cm Petri plate for 7-10 days at 23°C. The mycelium was scraped directly from the surface of the agar culture and weighed. Total genomic DNA was extracted by the methods of Lee and Taylor (1990). Then, ITS/5.8S rDNA regions of the test fungus MFC2 were amplified using a Mastercycler® personal thermo cycler (**Eppendorf**, Germany). For the PCR reaction the universal primers, ITS5 5'GGA-AGT-AAA-AGT-CGT-AAC-AAG-G3' and ITS4 5'TCCT-CCG-CTT-ATT-GAT-ATG-C3', were used (White et al. 1990). PCR was performed in a 50 µl reaction containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 1 unit Master *Taq* polymerase (**Eppendorf**) in a buffer of 10X Reaction buffer included 1.5 mM Mg^{2+} and 5X TaqMaster PCR Enhancer. The PCR cycling conditions consisted of denaturation at 94°C for 1.5 min, annealing at 55°C for 2.5 min, and extension at 72°C for

3 min for 40 cycles, with a final extension at 72_C for 10 min (Willits et al., 1999). Agarose gel electrophoresis followed by UV spectrophotometry then allowed for the examination of the PCR product (Bio Imaging Systems, SYNGENE, Synoptics Limited, Cambridge, United Kingdom). The PCR product of strain MFC2 was sent to the BIOSERVICE UNIT, National Science and Technology Development Agency for sequencing. Nucleotide sequences of ITS/5.8S rDNA regions of the MFC2 were determined manually on both strands and submitted to GenBank with a serial number **AY244622**.

Searching and Comparison ITS 1-2 and 5.8S rDNA sequences

The ITS1-2 and 5.8S rDNA sequence of culture collection MFC2 were submitted to GenBank with serial numbers. These sequences were also searched and compared with other fungal sequences under Blast 2.1 and a search of NCBI at the web site <http://www.ncbi.nlm.nih.gov/BLAST>. Comparison and alignment sequences were done using CLUSTAL W version 1.7 (Thomson and Gibson, 1997) and manually aligned Turn on or off automatic formatting of hyperlinks

1. On the Tools menu, click AutoCorrect, and then click the AutoFormat As You Type tab.
2. Under Replace as you type, select (check) or clear (uncheck) the Internet paths with hyperlinks check box. afterwards.

RESULTS AND DISCUSSION

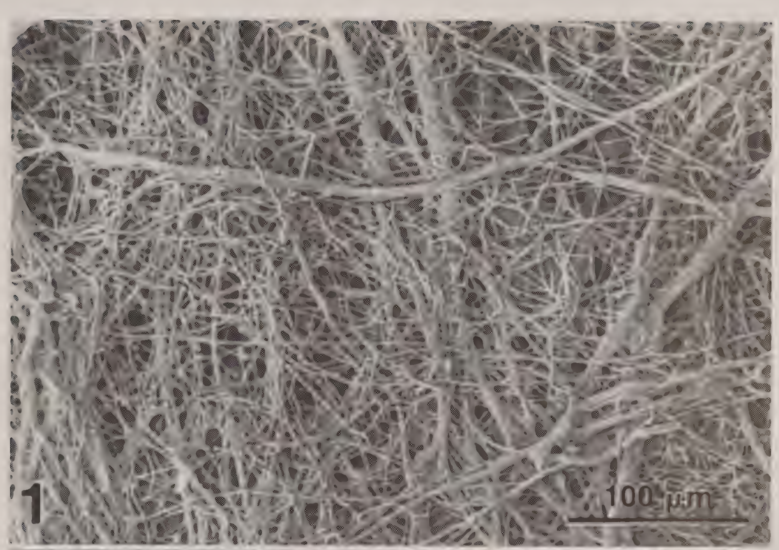
Fungal Description

In nature the isolate MFC2 is associated with *Myristica fragans* (Myristicaceae) and is a deuteromycete belonging to Mycelia Sterilia. This fungus produces whitish colonies on all media tested as well as growth on leaves and wood cuttings of several plant species, including those of *Myristica fragrans*. There are no spores or fruiting-bodies of this fungus observed under any conditions with any of the media tested. The mycelium grown on PDA produces a vast array of intertwined hyphae. The hyphae are (0.5-3.0 μm in diameter) commonly grown by intertwining angular branches without any coiled-loop structures (Fig 1-4).

The fungus has affinity to the *Xylariaceae* based on a 92-94% homology of the ITS1-2 and 5.8S rDNA between the Thai isolate of MFC2 and *Xylaria* spp. in the GenBank database. The ITS1-2 and 5.8S rDNA sequences of MFC2 show a 99% homology with *Muscodor albus* and *Muscodor roseus*, and 92% homology with *Muscodor vitigenus* (Fig 5). This confirms its placement in the same genus *Muscodor*. Because of the whitish nature of the mycelium, we provisionally identify this with *Muscodor albus* rather than *M. roseus*.

Molecular Biology of *Muscodor albus* isolate MFC2

While the 5.8S region is highly conserved the ITS regions are variable and useful for distinguishing species. Thus, ITS/5.8S sequences of *Muscodor albus* isolate MFC2 were obtained and compared with data in GenBank. Comparative analysis of the ITS 1&2 and 5.8S rDNA sequences (590 base pairs) of *Muscodor albus* hits ITS 1&2, and 5.8S of *Muscodor albus* (AF324336, 592 bp), *Muscodor roseus* (AY034664, 561 bp), *Muscodor vitigenus* (AY100022, 563 bp), *X. arbuscula* CBS 452.63 (AF163029), and *Hypoxylon fragiforme* (HFR246218) at 98, 99, 92, 92, and 91% homologies, respectively. No total identities were found; however, the 99% similarity of the ITS1&2 and 5.8S rDNA provides molecular justification that *Muscodor albus* isolate MFC2 should be considered the same species as *Muscodor albus* (Worapong, Strobel, Hess). Although MFC2 had a 99% homology with *M. roseus*, it lacks a reddish pigment in culture which resulted in the placement of the Thai material with *M. albus* which has 98% homology to this fungus.



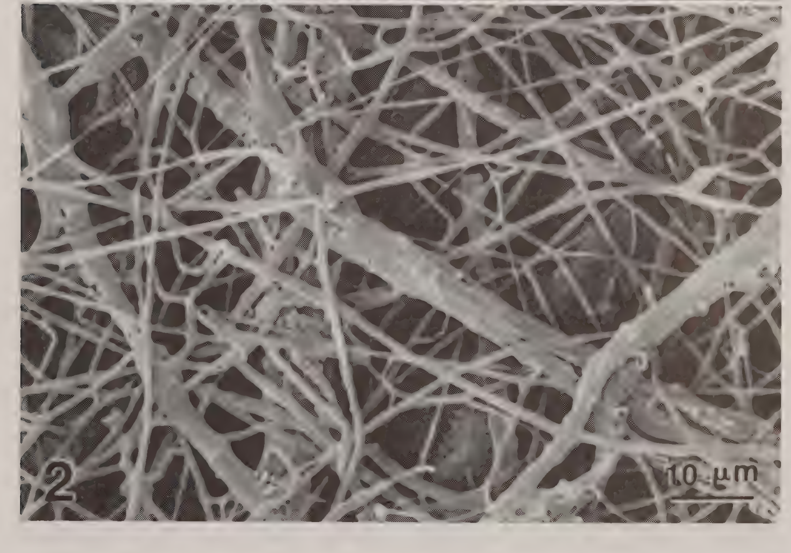
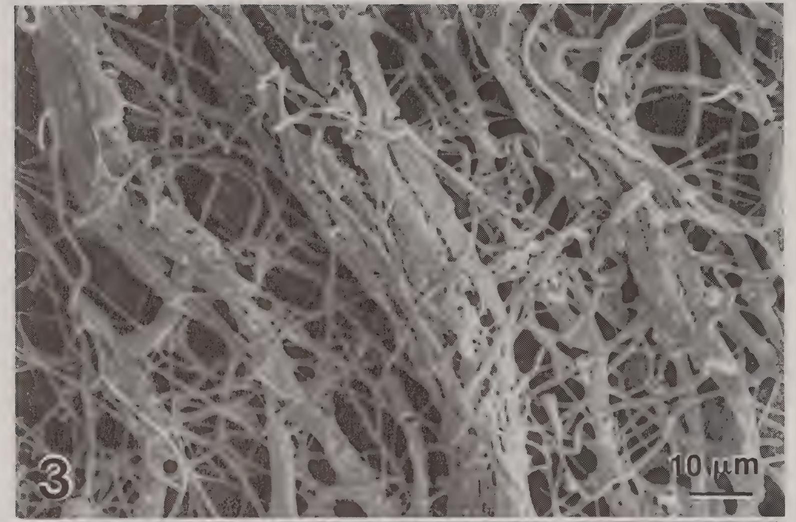


Fig. 1. Scanning electron micrograph of intertwined hyphae and mycelium of the Thai strain of *Muscodor albus* growing on PDA.

Fig. 2. Scanning electron micrograph of hyphae of *M. albus*. The diameter of the hyphae varies dramatically. Please note the branching of individual hyphae is more angular than right angular.



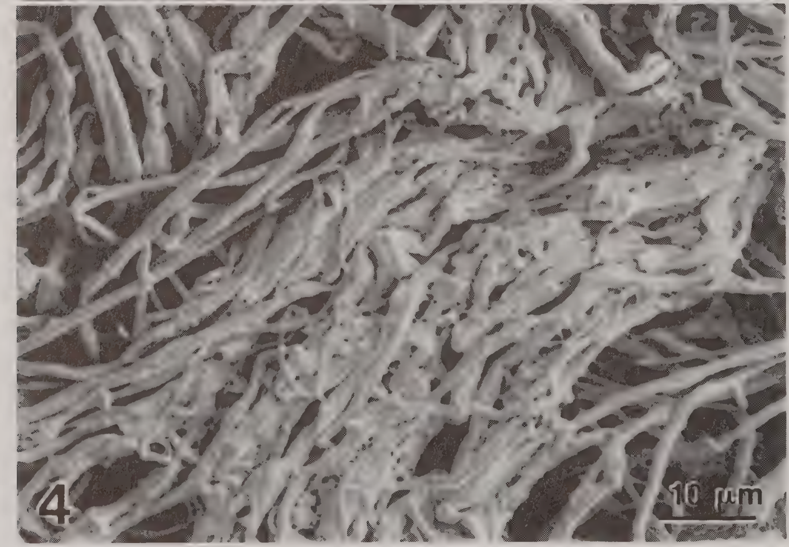


Fig. 3. Scanning electron micrograph showing the tightly compressed less ropy strands of mycelium of *M. albus*, the Thai strain.

Fig. 4. Scanning electron micrograph of tapering hyphae appearing to make a mycelial mat.

```
                   1                                                          60
M. albus(MFC2)     CCGTTGGTGAACCAGCGGAGGGATCATTACTGAGTTTTCGTGAACTCCCAACCCTATGTG
M. roseus          .......................................-....................
M. albus           .......................................-C...................
M. vitigenus       ....A..................................-....................

                  61                                                          120
M. albus(MFC2)     AACTTACCTTTGTTGCTTCGGCGGCGGAGGCTACCCTATAGGGGA-TACCACATAGTGGT
M. roseus          .............................................-..............
M. albus           .............................................-..............
M. vitigenus       .....................................GCG..A..A......T.......

                 121                                                          180
M. albus(MFC2)     TACCCTGTAGTCCCAGGTGCTAGATCGTGCTCAACGTCTTATCGTCTACGACTAGCTACC
M. roseus          ................A...........................................
M. albus           ............................................................
M. vitigenus       ...........TT.....A.---...---------------------------.......

                 181                                                          240
M. albus(MFC2)     CGGTGGCCCTCCCCGCCGGCGGCCAACTAAACTCTGTTTT-TATGGCATTCTGAATTATA
M. roseus          ........................................-...................
M. albus           ........................................-...................
M. vitigenus       ....A.T.A...............................C.T...A.........A.C.

                 241                                                         300
M. albus(MFC2)     AACTTAATAAGTTAAAACTTTCAACAACGGATCTCTTGGTTCTGGCATCGATGAAGAACG
M. roseus          ............................................................
M. albus           ............................................................
M. vitigenus       ............................................................

                 301                                                         360
M. albus(MFC2)     CAGCGAAATGCGATAAGTAATGTGAATTGCAGAATTCAGTGAATCATCGAATCTTTGAAC
M. roseus          ............................................................
M. albus           ............................................................
M. vitigenus       ............................................................

                 361                                                         400
M. albus(MFC2)     GCACATTGCGCCCATTAGCATTCTAGTGGGCATGCCTGTTCGAGCGTCATTTCACCACTT
M. roseus          ....................................................-.......
M. albus           ....................................................C.......
M. vitigenus       ............................................................

                 401                                                         460
M. albus(MFC2)     AAGCCCTGTTGCTTAGCGTTGGGAGCCTACGGCACTGCCCGTAGCTCCCTAAAGTGATTG
M. roseus          ............................................................
M. albus           ............................................................
M. vitigenus       .....T.............................G............T...........

                 461                                                         500
M. albus(MFC2)     GCGGAGTTGGTTCTCACTCTAGGCGTAGTAAATCTATCTCGCCTCTGTAGTGGTTCCGGC
M. roseus          ............................................................
M. albus           ............................................................
M. vitigenus       .....................A...........A........T...........C.....

                 501                                                    555
M. albus(MFC2)     CCCTGCCGTAAAACCCCCTATATCAAAGGTTGACCT-GGATCAG-TAG-AATACC
M. roseus          ....................................C.......G...G......
M. albus           .......................................................
M. vitigenus       .................T....-................................
```

Fig. 5. Sequence alignment of ITS1, 5.8S and ITS2 regions of *M*uscodor *albus* isolate MFC2, *M. roseus*, *M. albus* and *M. vitigenus*. The conserved positions are indicated with dots, and insertion-deletion positions with dashes.

It is noticeable that there are 30 base pairs of insertion or deletion in the ITS1 region (Fig. 5). Thus, there are only 92-93% homologies of ITS1, 5.8S, and ITS2 regions between *Muscodor vitigenus* and the other three species of *Muscodor*. High homology of ITS1 5.8S, and ITS2 among *M. albus*, *M. roseus* and *M. albus* isolate MFC2 may be an evolutionary implication concerning the type of their hosts which are trees or vines. For example, the host of *M. albus* and *M. albus* isolate MFC2 are the spice trees *Cinnamomum zeylanicum* and *Myristica fragrans*, respectively. In contrast, the host of *Muscodor vitigenus* is an herbaceous vine. Nonetheless, more isolates of *Muscodor* spp. from vines and spice trees should be studied.

Fungal Biology

The fungus produced white mycelia on the wood chips of numerous plant species, including the bark of *Myristica fragrans*, as well as on water based media. No fruiting structures or spores of any kind have been found under any laboratory conditions (Figs. 1-4). Hyphae tend to intertwine to form rope-like stalks from which smaller cables or individual hyphae emerge and branch more angular than right angular compared to the three species of *Muscodor* currently known (Fig. 3). A coiled loop structure is produced by *Muscodor albus*, *M. roseus and M.* vitigenus, but was not found to be produced by *Muscodor albus* isolate MFC2 (Figs. 1-4).

Chemical characters between the *Muscodor* spp. vary largely; especially those of *Muscodor albus* isolate MFC2. Using standard GC/MS methods, of the complex lipids present, *Muscodor albus* isolate MFC2 growing on PDA produced mostly azulene derivatives including bulnesene, ledol and (-)-globulol being the most prominent. However, both esters and alcohols were the most abundant volatiles produced by this fungus and their presence mimics that of *M. albus*. These compounds include propanoic acid, 2-methyl; 1-butanol, 3 methyl, acetate; 1-butanol, 3 methyl and ethanol when grown on PDA. It is to be noted that ledol and (-)- globulol have not been previously observed in any of the *Muscodor* species identified to date. *Muscodor albus* isolate MFC2 produced little or no naphthalene or naphthalene derivatives on PDA as did the original isolate of *M. albus* (Strobel et al., 2001). Naphthalene derivatives are included among the 26-28 different volatile compounds including alcohols, esters, ketones, acids, and lipids that are produced by *M. albus* and *M. roseus* (Strobel et. al., 2001), and naphthalene is the most abundant volatile produced by *M. vitigenus* (Daisy et al., 2002b). This profile of volatile compounds lends chemical support to the argument that *M. albus* isolate MFC2 is chemically distinct from *M. albus* and *M. roseus*. However, the high degree of homology with *M. albus* and the low number of species and isolates known to date prevent us from recognizing this as a new species. The volatiles of *M. albus* isolate MFC2 partially to totally inhibit the pathogenic fungi and bacteria that infected the rice seed strain Prathumthanee 1, but these volatile compounds have no effect against human pathogens such as *Escherichia coli* and *Candida albicans* (data not shown). Thus, *M. albus* isolate MFC2 may have potential for agricultural uses.

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REFERENCES

Bruns, T.D., White, T.J., and Taylor, J.W. 1991. Fungal molecular systematics. Annual Review Ecology Systematics 22: 525-564.

Daisy, B.H., Strobel, G.A., Castillo, U., Baird, G., and Hess, W.M. 2002a. *Muscodor vitigenus* anam. sp. nov. an. endophyte from *Paullinia paullinioides*. Mycotaxon 84: 39-50.

Daisy, B.H., Strobel, G.A., Castillo, U., Ezra, D., Sears J., Weaver, D. K., and Runyon, J.B. 2002(b). Naphthalene, an insect repellent, is produced by *Muscodor vitigenus*, a novel endophytic fungus. Microbiology 148: 3737-3741.

Guarro, J., Gené, J., and Stchigel, A. M. 1999. Developments in Fungal Taxonomy. Clinical Microbiology Reviews 12(3): 454-500.

Harborne, J. B., Baxter, H., and Moss, G. P. 1999. Phytochemical Dictionary, A Handbook of Bioactive Compounds from Plants, 2nd edition, TAYLOR & FRANCIS, London: 946.

Lee, S. B. and Taylor, J. W. 1990. Isolation of DNA from fungal mycelia and single spores. In PCR Protocols A guide to Methods and Applications. Edited by Innis, M. A., Gelfand, D. H., Sninsky J. J., White, T. J. Academic Press, Inc., California: 282-287.

Mitchell, J.I., Roberts, P.J., and Moss, S.T. 1995. Sequence or Structure? A Short Review on the Application of Nucleic Acid Sequence Information to Fungal Taxonomy. Mycologist 9: 67-75.

Reynolds, J., and Taylor, J.W. 1993. The Fungal Holomorph: Mitotic, Meiotic, and Pleomorphic Speciation in Fungal Systematics. Proceedings of an International Symposium Wallingford: C.A.B. International.

Strobel, G.A., Yang, X., Sears, J., Kramer, R., Sidhu, R.S., and Hess, W.M. 1996. Taxol from *Pestalotiopsis microspora*, an endophytic fungus of *Taxus walliachiana*. Microbiology 142: 435-440.

Strobel, G.A., Dirske, E., Sears, J., and Markworth, C. 2001. Volatile antimicrobials from *Muscodor albus*, a novel endophytic fungus. Microbiology 147: 2943-2950.

Taylor, J.W., Jacobsen, D.J., and Fisher, M.C. 1999. The Evolution of Asexual Fungi: Reproduction, Speciation, and Classification. Annual Review Phytopathology 37: 197-246.

Thomson, J. and Gibson T. 1997. Clustal V Multiple Sequence Alignments. In: Documentation (Installation and Usage) European Molecular Biology Laboratory Postfach Germany: 1-37.

White, T.J., Bruns, T., and Taylor, J.W., 1990. Amplification of direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR Protocols: A Guide to Methods and Applications. Edited by Innis, M.A., Gelfand, D.H., Sninsky J.J., and White, T.J. Academic Press, Inc., California: 315-324.

Willits, D. A. and Sherwood, J. E. 1999. Polymerase Chain Reaction detection of *Ustilago hordei* in leaves of susceptible and resistant barley varieties. Phytopathology 89: 212-217.

Worapong, J., Strobel, G.A., Ford, E., Li, J.Y., Baird, G., and Hess, W.M. 2001a. *Muscodor albus* anam. gen. et sp. nov., an. endophyte from *Cinnamomum zeylanicum*. Mycotaxon 79: 67-79.

Worapong, J., Strobel, G.A., Daisy, B.H., Castillo, U., Baird, G., and Hess, W.M. 2001b. *Muscodor roseus* sp. nov. an. endophyte from *Grevillea pteridifolia*. Mycotaxon 81: 463-475.

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AMANITACEAE REPORTED FROM INDIA. A CRITICALLY ANNOTATED CHECKLIST

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Abstract

Since the appearance of *Amanitaceae of India* in 1990, there has been no publication addressing the current state of knowledge of the family in India. The present paper represents a step toward filling this gap and providing an updated list of those members of the Amanitaceae described, illustrated or listed from different parts of India to date. The list includes 53 names, of which 50 names are combined in *Amanita* and the rest in *Limacella*. Revision of collections determined originally as European or North American taxa has yielded fifteen new records for India: *A. avellaneosquamosa*, *A. caesareoides*, *A. clarisquamosa*, *A. concentrica*, *A. exitialis*, *A. liquii*, *A. oberwinklerana*, *A. orientigemmata*, *A. pantherina* var. *lutea*, *A. pseudoporphyria*, *A. pseudovaginata*, *A. rubrovolvata*, *A. subjunquillea* var. *subjunquillea*, *A. subjunquillea* var. *alba*, and *A. umbrinolutea*. It is projected that the number of *Amanita* taxa in India may exceed 100.

Keywords: China, Himalayan region, Japan

INTRODUCTION

Assemblages of ectomycorrhizal fungi associated with coniferous and oak-dominated forest communities in the Himalayan foothills of northwestern India and the mid-Appalachians of the eastern United States are the subject of an on-going study by the authors and a number of their colleagues. This paper, which presents an annotated checklist of the Indian Amanitaceae, is a step in documenting the distribution, ecology, and taxonomy of this group of agarics for the Indian region of interest. The foundation of the checklist is an extensive search of the literature. The extracted data has been critically reviewed based on relevant dried collections as well as new collections made during the current study.

Brief Comments on the Amanitaceae

The name "Amanitaceae" is often attributed to Roze (1876*a*, 1876*b*). However, he only named the family in French. Heim (1934) was the first to use the name "Amanitaceae";

however, he fixed no type genus and provided no Latin diagnosis. During the 1970's there was considerable debate as to whether to sanction vernacular (e.g., French and German) family names and then allow the Latin endings to be added as orthographic corrections. However, in 1975, this position was defeated at the XIIth Botanical Congress; and the 1978 Code (Stafleu *et al.*, 1978) made clear that the names with vernacular terminations were inadmissible. Following this change in the code, Pouzar (1983), whose summary of nomenclatural history we here summarize further, proposed *Amanita* to be the type of the Amanitaceae and provided a Latin diagnosis. Moreover, Pouzar specified included genera (*Amanita* and *Limacella*) and gave a list of excluded genera (*Rhodotus*, *Termitomyces*, *Volvariella*, *Pluteus*, and *Chamaeota*). He recognized Heim as having had a "concept of families of Agaricales [that seemed] to be the best for his time." Following Pouzar, the correct citation of the name is "Amanitaceae R. Heim *ex* Pouzar."

According to most modern authors, the family Amanitaceae remains as defined by Pouzar (e.g., Singer (1986)). Members of the family are characterized by the following features: pure white to vividly colored pilei; fleshy basidiomes having free to narrowly adnate, broad to narrow, thin to slightly thickened lamellae; a universal veil (present at least in early development of the basidiome) that may take the form of a glutinous sheath, a saccate or cupulate or limbate volva, a band along the margin of a marginate stipe bulb, or a sequence of floccons, warts, mealy matter, banded ring zones etc. on the lower stipe or stipe bulb (and in such cases often leaving volval patches, floccons, or warts on the surface of the pileus); in many taxa, a partial veil membranous and persistent to felted or flocculent and deciduous or ephemeral; lamella trama that are bilateral at least at some stage of development of the basidiome; context of the pileus and stipe that are monomitic, inamyloid, with or without clamp connections, often with some refractive or vascular hyphae; terminal hyphal cells that are often strongly inflated acrophysalides, with such cells longitudinally oriented in the stipe; basidia normally dominantly 4-spored in mature material, with less than a half-dozen notable exceptions in *Amanita* (one known from East Asia and the remainder from North and Central America), with or without basal clamp connections; cystidia lacking (with the possible exception of a very few species in *Amanita* in which vascular pseudocystidia protrude among the basidia and basidioles); vesiculose, deciduous cells on the edges of the lamellae in many species; spore color in mass white, cream, pale yellowish, pale sordid, or pale greenish; spores varying from globose (length/breadth ratio between 1.0 and 1.05) to bacilliform (length/breadth ratio greater than or equal to 3.0), mostly subglobose to broadly ellipsoid to ellipsoid (length/breadth ratio between 1.05 and 1.6), smooth, usually colorless, hyaline, usually thin-walled (with wall thickened in some taxa), with wall rarely reported to have minute punctation or "stippling" (particularly in *Limacella*), amyloid or inamyloid. Mostly occurring on earth or humus in wooded areas and, in *Amanita*, predominantly obligately ectotrophically mycorrhizal.

At present, the levels of knowledge of the two genera differ significantly, with our understanding of *Limacella* the much less advanced of the two. *Amanita* can be defined by three characters in combination: bilateral lamella trama, longitudinally acrophysalidic stipe tissue, and the schizohymenial type of development of the basidiomes (Bas, 1969: 294; Yang and Oberwinkler, 1999).

Singer (1986) listed 115 species in the family Amanitaceae, of which 100 species belongs to the genus *Amanita* and 15 to the genus *Limacella*. Gilbert (1918) in his compilation of information on European species of *Amanita sensu lato* described 21 species of the genus *Amanita*, 3 of *Amanitopsis*, and 6 of *Limacella*. He also included a large number of infraspecific taxa. In his magnum opus on the Amanitaceae, Gilbert (1940-41) described and provided colored illustrations for many members of the family—including many from eastern Asia. Corner and Bas (1962) described 30 species of the genus *Amanita* from Singapore and Malaya. In the most important work on *Amanita* to date, Bas (1969) transformed the methodologies of study of the genus, provided keys to the subgenera and sections of *Amanita*, and described 93 species belonging to *Amanita* section *Lepidella* worldwide—including 16 new species. Jenkins (1986) compiled data on species of *Amanita* in North America and described in brief and illustrated 128 species. Tulloss (e.g., 1993, 1994; Tulloss *et al.*, 1992, 2001) expanded on the methodology of Bas and has concentrated on *Amanita*—treating over 70 species from around the world in detail. Zhu L. Yang also expanded on the methodology of Bas. In his work on the *Amanita* species of southwest China, Yang (1997) provided excellent illustrations and meticulously detailed descriptions of 47 taxa, most at species rank.

At this writing, the CABI Bioscience database of fungal names (Funindex) shows 1089 records under the genus *Amanita* and 48 records under the genus *Limacella* from the world over, however, a significant number of names included in the list are either synonyms or not validly published. According to C. Bas and Tulloss (unpub. data), the number of accepted names in *Amanita* is less than 600 at present; and this number is expected to include taxonomic synonyms. Bas (2000) and Tulloss (2000*a*) estimated the number of *Amanita* taxa in the world to be 900 to 1,000 species.

Overview of the Indian Literature

The Indian literature gives the impression that little attention has been paid to the agaric flora of this country although the Indian subcontinent with the mighty Himalayas in the north, is bestowed with a geographical area abounding in forest and possesses varied topography and a vast range of climates. Such a diversity of habitat is conducive to growth of a large variety of mushrooms, and there is an equally large opportunity to explore the mushroom flora of this country's various geographical regions.

From time to time, information about Indian Amanitaceae has been published in various checklists, research articles, books, and monographs. We have reviewed such publications ranging from Butler and Bisby (1931) to the present.

Butler and Bisby (1931) listed one species of *Amanita* and five species of *Amanitopsis* from the Khasi Hills, Assam and Darjeeling, West Bengal. Vasudeva (1960) revised the work of Butler and Bisby and repeated the records previously listed.

Bilgrami *et al.* (1979) listed two species of *Amanita* from the Khasi Hills, Assam; Solan, Himachal Pradesh; and Lucknow, Uttar Pradesh, and five species of *Amanitopsis* from the Khasi Hills, Assam and Darjeeling, West Bengal.

Sathe and Daniel (1980), Sathe and Deshpande (1980), and Sathe and Kulkarni (1980) described three species of *Amanita* from Poona, Maharashtra; Munnar, Kerala; and Sampaje, Karnataka and one species of *Limacella* from Quilon, Kerala. All four species were new to science.

Watling and Gregory (1980) listed three species of *Amanita* from Sonamarg, Gulmarg and Sarband near Harwan, Kashmir.

Manjula (1983) listed nine species of *Amanita*. Purkayastha and Chandra (1985), in their *Manual of Indian Edible Mushrooms*, listed three species of *Amanita* from the Khasi Hills, Assam; Kerala; Solan, Himachal Pradesh; Lucknow, Uttar Pradesh and Sarband near Harwan, Kashmir, and two species of *Limacella* from Calcutta, West Bengal and Orissa.

Natarajan (1977), Natarajan and Purushothama (1987), Purushothama and Natarajan (1987) treated a total of three taxa from southern India.

Bhatt *et al.* (1988) described four species of *Amanita* in detail for the first time from the forests of Himachal Pradesh. Shajahan *et al.* (1988) described two species of *Amanita* and one species of *Amanitopsis* from Shella and Shillong, Khesi Hills (Meghalaya) along with a number of other macrofungi.

Dhancholia (1989) briefly described and illustrated seven species of *Amanita* out of a reported ten from Orissa. Further, Dhancholia *et al.* (1991) reported *Amanita phalloides* from the Almora Hills, Uttaranchal. Abraham and Kachroo (1989) listed 12 species of *Amanita* from Jammu and Kashmir. Kumar *et al.* (1990*b*) included 11 species in a listing of fungi recorded from a series of study areas near Narkanda in Himachal Pradesh.

The first book length contribution on the Indian Amanitaceae was made by Kumar *et al.* (1990*a*). They presented an account of 25 Indian taxa of *Amanita*.

In the recent edition of *Fungi of India*, Bilgrami (1991) listed five species of *Amanita*, five species of *Amanitopsis* and one species of *Limacella*. In another recent report, Sarbhoy *et al.* (1996) listed 12 species of *Amanita*.

Working on the mushroom flora of Garhwal Himalaya, Bhatt and Bhatt (1996) and Bhatt *et al.* (1999) described and illustrated seven species of *Amanita* new to the Indian mycota.

Doshi and Sharma (1997) listed two species of *Amanita* and one species of *Amanitopsis* from Rajasthan. Pandotra (1997) listed 12 species of the genus *Amanita* in his book on the fungi of north India. Kaur and Atri (2002) list two species from Punjab plains.

GOALS AND METHODS

This paper is a contribution towards one component of an international project with the objective of comparing the assemblages of ectomycorrhizal macrofungi that occur in certain forest ecosystems of the eastern United States and northwestern India that are montane in distribution and often dominated by members of the Pinaceae and Fagaceae. The project encompasses research in both mycology and forest ecology, and one group of fungi receiving particular interest is the Amanitaceae.

An important foundation for our study of this family in India was gathering and reviewing the relevant Indian literature. In order to evaluate the reports in the literature gathered, we began carrying out a revision of specimens that were at hand in BPI, GUH, HPUB, and the personal herbarium of Tulloss. Many of these were collected by the authors, their colleagues, and their students. Hence, we turned our critical eye first on the work of ourselves and close colleagues.

Recent information on Indian Amanitaceae is scattered in various journals and technical publications that are not readily available to the scientific community. The present catalogue has the following goals: (1) assembling the available information on records of Indian Amanitaceae, (2) initiating a critical review of these records to suggest directions for the taxonomic component of our research and to improve the accuracy of the list, and (3) assembling an updated list of taxa reported for India.

To the extent possible, all taxa of the Amanitaceae recorded and published from India have been catalogued in the present communication. A total of 53 names (excluding synonyms) have been reported so far from India; 50 of these are epithets combined in *Amanita* and three in *Limacella*. The number of taxa represented is unclear, but this subject is discussed at the level of detail possible at an early stage of the project. At the end of this paper, a provisional revised list of Indian *Amanita* taxa is provided and an estimate of the potential number of *Amanita* taxa that may be found in India is given.

The list of taxa is given in alphabetical order for each genus. The taxa are listed by what we believe to be the correct name of each. When the correct name differs from that appearing in some of the reviewed publications, the other names are provided in remarks associated with each name's list entry. For each taxon, the following are provided: author citation and place of publication, nomenclatural status and status with regard to acceptance as a correct name for a taxon, references to the literature, localities where collections were made (following "**L**:"), and taxonomic remarks (following "**R**:") as required. Names accepted as correct are annotated by the phrase "Accepted name." Author citations conform to those provided by Kirk and Ansell (1992) with the exception of "E. J. Gilbert" (in which case we preserve the order of the author's initials used on the main body of his work, including his magnum opus—the order that has been used by the leading students of *Amanita* for the past 40 years and more).

Herbarium name codes follow Holmgren, Holmgren and Barnett (1992).

New Records

The total of *Amanita* taxa known for eastern and southern Asia exceeds 140. When their affinities are examined, the distribution of almost all taxa seems to be restricted to eastern and southern Asia, including peninsular southeast Asia. It is not a surprise then that, in most cases, it is determination of Indian material under an Australian, European, or Western Hemisphere name that has been found to be in error. In the past there has been limited monographic literature available for Asian species; however, this problem has been rectified to a great degree by the work of several authors in the last decades. In particular, the recent work of Z. L. Yang has made excellent, detailed species descriptions available. Most of his taxonomic work is now in English, but his thesis, in German (Yang, 1997), is very important to accurate determinations in southern and eastern Asia. In revising material for this project, we have found most useful the combination of Yang's publications, a number of recent publications from Japan including those of T. Oda and co-authors, the seminal work of Corner and Bas (1962) and, for section *Lepidella*, the monograph of Bas (1969). The time has come for these works to become major points of reference for Indian students of *Amanita*—replacing non-Asian field guides and technical works not treating Asian taxa, such as Jenkins' (1986) compendium of described *Amanita* taxa of North America.

It cannot be overemphasized, that collectors in southern Asia should look at unfamiliar material as most likely to be endemic to Asia and, potentially, new. In any case, good field notes, carefully dried exsiccata (or material preserved in liquid), and drawings or photographs of fresh material are very important to progress in Asian *Amanita* taxonomy. There is considerable need for more information even on familiar taxa. When microscopic anatomy is reviewed, we strongly suggest that specimens be treated as "unknowns" and worked up thoroughly. We strongly recommend either of the methodologies followed by Tulloss (1998*b*, 2000*b*) or by Yang (1997). Macroscopic appearances can be deceptive in terms of determination. For example, it is not at all clear how many different taxa are reported as varieties of *A. gemmata* and *A. pantherina* in southern Asia. Yang lists several distinct taxa in his works and is in the process of publishing new taxa in the "*pantherina* group." Our experience to date suggests there may be still *other* members of the group in India and Pakistan.

In addition to finding that a number of names have been misapplied, new names proposed based on Indian material have proven to be taxonomic posterior synonyms, in a few cases.

In both cases, revision has resulted in identification of taxa, which are herein recorded for the first time from India. Publications treating these new records in detail will be forthcoming. For the time being, we simply record the names of these taxa under appropriate entries in the list of taxa that follows and in Table 1 at the conclusion of this paper.

CHECKLIST OF TAXA

Genus *Amanita* Pers.
Type species: *A. muscaria* (L.:Fr.) Pers. *Tentam. Disp. Meth. Fung.*: 67. 1794. [Conserved name]

1. *Amanita albocreata* (G. F. Atk.) E. J. Gilbert. *Iconogr. Mycol. (Milan)* 27, suppl. (2): 259. 1941. [Accepted name] **L**: Uttaranchal: Garhwal, Kandolia and Nagdev-Jhandidhar (Bhatt *et al.*, 1999). **R**: This species is known only from mixed forests in northeastern North America. Bhatt *et al.* (1999) reported it from Garhwal, Uttaranchal. Reexamination of this collection along with additional material obtained during subsequent years has shown that the taxon present in India matches very well the original description of *A. orientigemmata* Zhu L. Yang & Yoshim. Doi (1999), which was known from Japan and southwestern China prior to this preliminary report of its occurrence in India.

2. *Amanita alboflocossa* A. V. Sathe & S. D. Deshp. *MACS Monograph* 1: 14. 1981. [Accepted name] **L**: Maharashtra: Poona (Sathe and Deshpande, 1980). **R**: This species was described originally from Poona, Maharashtra, India and, to our knowledge, is known only from the type locality.

3. *Amanita aporema* Boedijn. *Sydowia* 5: 319. 1951. [Accepted name] **L**: Orissa: Phulbani, Kalinga (Dhancholia, 1989). **R**: The description of the Orissa material conforms to what is known of Boedijn's species except for the statement that no clamp connections were found. Clamp connections were found to be common throughout the holotype of *A. aporema* by Yang et al. (to appear) leading the authors to believe that the species is "more closely related to *A. princeps* Corner & Bas [of *Amanita* stirps *Hemibapha*

(Tulloss, 1998*a*)] than to *A. fulva* and its allies." It would be valuable to re-examine the material of Dhancholia.

4. *Amanita aureofloccosa* Bas. *Persoonia* 5: 384, figs. 92-95. 1969. [Accepted name] **L**: Punjab: Sirhind, New Awadi (Kaur and Atri, 2002). **R**: *Amanita aureofloccosa* was described based on material from Congo. The entity described by Kaur and Atri differs from the central African species at least in having a distinct basal bulb on the stipe, a more robust habit, and thin-walled spores. Kaur and Atri do not describe the stipe's interior. The African species has a notably hollow stipe from early in development (Bas, 1969). Kaur and Atri's collection may represent the same species reported by Purushothama and Natarajan (1987) as *A. flavofloccosa* (see below). It would be valuable to revise the Punjabi material.

5. *Amanita berkeleyi* (Hook. f. *in* Berk.) Bas. *Persoonia* 5: 476. 1969. [Accepted name] **L**: West Bengal: Darjeeling (Berkeley, 1850: 43 as *Agaricus*); Jillapahar (Berkeley, 1850: 42 as *Agaricus regalis* Berk.). Himachal Pradesh: Shimla, Taradevi and Fagu (Bhatt *et al.*, 1988); Chadwick Fall and Narkanda (Kumar *et al.*, 1990*a*; 1990*b*). **R**: This species was described originally from India. Judging by the lack of recent collections, it is rare or, perhaps, restricted in its symbionts (e.g., associated only with dipterocarps). Bas (1969) knew it only from the holotypes of the two taxa whose names he placed in synonymy. More recently collected material determined as *A. berkeleyi* that has been revised by us has proven to be *A. fritillaria*. Any Indian material determined as *A. berkeleyi* in the past is worth revising, and new material is badly needed for study.

6. *Amanita bharatensis* A. V. Sathe & Jeys. Daniel. *MACS Monograph* 1: 75. 1981. [Tentatively accepted name] **L**: Kerala: Munnar (Sathe and Daniel, 1980). **R**: This species was described originally from India. The original published description contains some conflicting elements and assignment to section is problematic. A review of the type and collection of new material is desirable. See *A. muscaria* subsp. *muscaria*, below.

7. *Amanita calyptratoides* Peck. *Bull. Torr. Bot. Club* 36: 329. 1909. [Accepted name] **L**: Orissa: Phulbani, Daringbadi (Dhancholia, 1989). **R**: This species is known only from a limited range in the Western Hemisphere [from southern California, USA to the neovolcanic zone of central Mexico (Tulloss, unpub. data)]. It is very unlikely to be found in India. Dhancholia's description of the Indian material conflicts with that of *A. calyptratoides* at least in having an ochraceous pileus and spores 7.8 - 10 × 5.6 - 7 μm. The North American species has a lead (gray-brown) pileus with spores (9.4-) 9.8 - 13.2 (-15.0) × (6.0-) 6.8 - 8.9 (-9.9) μm (Tulloss, unpub. data). Because the mushroom is described and illustrated as though it had a bulbous base, it might belong in *Amanita* section *Phalloideae* (Fr.) Quél. Unfortunately, the reaction of spores to Melzer's reagent was not reported. Indian material determined as *A. calyptratoides* in the past should be revised.

8. *Amanita ceciliae* (Berk. & Broome) Bas. *Persoonia* 12: 192. 1984. [Accepted name] **L**: Uttar Pradesh: Allahabad, (as *Amanita inaurata*, Singh and Mehrotra, 1974). Himachal Pradesh: Kullu, Jaloripass, Sojha, Pulga, Rahla Fall; Shimla, Narkanda (Kumar *et*

al., 1990*a*; 1990*b*). Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: *Amanita inaurata* Secr. *nom. inval.* is a synonym that commonly appears in the literature. The species seems to be limited to Europe and adjacent western Asia. It has never been demonstrated to be exportable with symbionts. Recently, Z. L. Yang (pers. corresp.) has found that the species commonly determined as *A. ceciliae* in southern China is a distinct species soon to be published as *A. liquii* Zhu L. Yang, M. Weiss & Oberw. (to appear). Abraham and Kachroo (1989) describe a pileus for their "*ceciliae*" that is "pale indigo to grayish … blue" and, hence, not the yellowish to brown European taxon. They describe a second species as "*inanurata*" [sic] that seems very similar to the new taxon of Zhu L. Yang *et al.* From incomplete revisions of Indian material similar to *A. ceciliae*, we believe that there are additional taxa that have been recorded under this name. We have revised some material of *A. ceciliae sensu* A. Kumar *et al.* and find that the material examined is assignable to *A. umbrinolutea* (Secr. *ex* Gillet) Bataille. For taxonomic details on the latter species, see Tulloss *et al.* (2001).

9. *Amanita citrina* (Schaeff.) Pers. *Tentam. Disp. Meth. Fung.*: 66. [Invalid combination] **L**: Jammu and Kashmir: Kashmir, Pahalgam (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: This species is reported from around the world; but, in point of fact, seems limited to Europe and adjacent western Asia. Reports of its exportation with a symbiont have been disproved to date. Recently, *A. sinocitrina* Zhu L. Yang, Z. H. Chen & Z. G. Zhang (Chen *et al.*, 2001) has been described from eastern Asia. Indian material previously determined as *A. citrina* should be compared to the Chinese species. Note: Unfortunately, *Agaricus citrinus* Schaeff. is a posterior homonym. The currently accepted name for the European taxon is *A. bulbosa* var. *citrina* (Schaeff.) Gillet.

10. *Amanita cokeri* (E. J. Gilbert & Kühner) E. J. Gilbert. *Iconogr. Mycol. (Milan)* 27 suppl. (2): 372. 1941. [Accepted name] **L**: Uttaranchal: Garhwal, Dandapani (Bhatt and Bhatt, 1996). **R**: This species is known only from eastern North America. Although reported from Garhwal, Uttaranchal by Bhatt and Bhatt (1996), it probably does not occur in India. Revision of Indian material previously determined as *A. cokeri* is currently underway by us. This material may comprise more than one species. One of the species involved is *A. concentrica* T. Oda, C. Tanaka & Tsuda (2002) described recently from Japan. In many ways, this species is deceptively like *A. cokeri* macroscopically; however, it is a species of *Amanita* section *Amanita* with inamyloid spores. Other material determined as *A. cokeri* might be *A. eijii* Zhu L. Yang (2002).

11. *Amanita craseoderma* Bas. *Persoonia* 10: 20. 1978. [Accepted name] **L**: Karnataka: Bentamale Forest, near Guthigar and Mannagundi, South Kahara (Natarajan and Purushothama, 1987). **R**: This species is known only from specialized tropical environments in South America. The material from Karnataka differs from the Amazonian species in having a different colored pileus, shorter striations on the pileus margin, a different colored stipe, a universal veil that appears to be submembranous rather than pulverulent, larger spores, etc. It is very unlikely that *A. craseoderma* would be found in India. Material determined as this species should be revised.

12. *Amanita elata* (Massee) Corner & Bas. *Persoonia* 2 (3): 286. 1962. [Accepted name] **L**: Orissa: Phulbani, Daringbadi (Dhancholia, 1989). **R**: *Amanita elata* is a species of *Amanita* section *Amanita*. The species described and illustrated by Dhancholia appears to belong in either *Amanita* section *Phalloideae* or *Amanita* section *Vaginatae* (Fr.) Quél. The material should be revised.

13. *Amanita emilii* Riel. *Bull. Trimestriel Soc. Mycol. France* 23: 1. 1907. [Name status unclear] **L**: Himachal Pradesh: Shimla, Glen (Bhatt *et al.*, 1988); Glen, Chadwick Fall, Taradevi, Charabara and Baghi (Kumar *et al.*, 1990*a*). **R**: This name is treated by many European authors as a posterior synonym of *A. regalis* (see, below). What little information exists on *A. emilii* would place it among the clamp-bearing taxa in the "*A. muscaria* group." However, the fact that the Indian material is reported to lack clamp connections suggests an affinity with *A. gemmata* or *A. pantherina*. Possibly, the material is assignable to *A. subglobosa* Zhu L. Yang (1997). We are proceeding with revision of the Indian material.

14. *Amanita eriophora* (Berk.) E. J. Gilbert. *Iconogr. Mycol. (Milan)* 27 suppl. (2): 230. 1941. [Accepted name] **L**: Punjab: Sirhind, Village Sheikhpura (Kaur and Atri, 2002). West Bengal: Darjeeling (Berkeley, 1850 as *Agaricus*). **R**: This species was described originally from India. To our knowledge, it is known in India only from the type locality. The material reported from Punjab differs greatly from *A. eriophora*—lacking a strongly marginate deeply rooting bulb, having a strong odor, lacking a thick layer of violet-tinted volval material over the upper two-thirds or more of the stipe, having larger more elongate spores, etc. From the lack of recent collections, *A. eriophora* may be rare or limited in its possible symbionts. Corner and Bas (1962) reported the species from Singapore.

15. *Amanita excelsa* (Fr.:Fr.) Bertillon *in* Dechambre. *Dict. Encycl. Sci. Med.* 1 (3): 499. 1866. [Accepted name] **L**: Jammu and Kashmir: Kashmir, Pahalgam (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: This species is not known to be exported from its native Europe and adjacent western Asia with symbionts. There are several taxa known from eastern Asia that may have been confused with this species. Material from India determined as this species should be revised.

16. *Amanita farinosa* Schwein. *Schr. Nat. Ges. Leipzig* 1: 79. 1822. [Accepted name] **L**: Rajasthan: Udaipur (Doshi and Sharma, 1997). **R**: This taxon is reported from eastern Asia and western North America as well as from Eastern North America, from which it was described. In general, many determinations of material collected outside eastern North America are in need of critical revision.

17. *Amanita flavoconia* G. F. Atk. *J. Mycol.* 8: 110. 1902. [Accepted name] **L**: Himachal Pradesh: Shimla, Glen and Taradevi (Bhatt *et al.*, 1988); Shimla, Glen, Baghi, Chajpur, Chopal, Charabara, Narkanda; Kullu, Manali, Pulga; Chamba, Kala Top and Khajjiyar (Kumar *et al.*, 1990*a*; 1990*b*). Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: Nearly all material from India that was determined as this species and has been revised has proven to be *A. flavipes* S. Imai (Tulloss *et al.*, 2001). *Amanita flavipes* appears to be common in northern India.

18. *Amanita flavofloccosa* Nagas. & Hongo. *Trans. Mycol. Soc. Japan* 25: 367. 1984. [Accepted name] **L**: Tamil Nadu: Madras (Purushothama and Natarajan, 1987). **R**: This species is a yellow one belonging in stirps *Nauseosa* of *Amanita* subsection *Vittadiniae* Bas (1969). The Tamil Nadu material is probably assignable to the same stirps. However, the protologue of *A. flavofloccosa* describes an entity with a differently colored pileus surface and gills, somewhat different habit (more elongate and lepiotoid) and notably larger spores than the entity described and illustrated by Purushothama and Natarajan. Revision of the Indian material would be worthwhile. Also, see *A. aureofloccosa*, above.

19. *Amanita franchetii* (Boud.) Fayod. *Ann. Sci. Nat. (Bot.)*, 7° Sér. 9: 316. 1889. [Accepted name] **L**: Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: This name is very widely misapplied in the Western Hemisphere to taxa of very different habits and pigmentations. In particular, North American literature is unreliable with regard to this species. The pileus of the European taxon is greenish yellow according to the protologue; however, the name is also applied in Europe to an entity with a gray-brown, virgate pileus and sulfur yellow warts. Indian material previously determined as this species should be revised.

20. *Amanita fritillaria* (Berk.) Sacc. *Syll. Fung.* 9: 2. 1891. [Accepted name] **L**: Assam: Khasi Hills (Berkeley1852 as *Agaricus*). Uttaranchal: Dehradun, FRI (Bakshi, 1974). Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: This species is a very distinctive one with a very dark universal veil. The center of the pileus is brown and notably virgate, while the pileus margin may be quite pale in some specimens.

21. *Amanita fulva* (Schaeff.) Fr. *Obs. Mycol.* 1: 2. 1815. [Accepted name] **L**: Himachal Pradesh: Shimla, Glen, Taradevi, Jakhoo and Fagu (Bhatt and Lakhanpal, 1988); Kullu, Rahla Fall, Manali, Pulga; Shimla, Narkanda (Kumar *et al.*, 1990*a*; 1990*b*). Orissa: Mayurbhanj, Joshipur (Das and Sinha, 1990). **R**: *Amanita fulva* is a name applied very loosely around the world to diverse taxa of *Amanita* section *Vaginatae* that lack an annulus and have brownish pilei. Western Hemisphere material treated under this name can be segregated into a number of indigenous taxa. Z. L. Yang (pers. corresp.) has recently found that Chinese and Japanese material treated as *A. fulva* in the past represents a distinct taxon indigenous to eastern Asia—*Amanita orientifulva* Zhu L. Yang, M. Weiss & Oberw. (to appear). Since *A. aporema* is in this checklist and since it was described in its protologue as strongly suggesting the European *A. fulva*, *A. aporema* should be considered as a possible determination for Indian material formerly classified as *A. fulva*. *Amanita fulva* is not known to be exportable from its native Europe and adjacent western Asia with symbionts. It is very unlikely that it would be found in India. All Indian material determined as *A. fulva* should be revised.

22. *Amanita fulvaurantia* R. P. Bhatt, Locq. and T. N. Lakh. *in* Kumar et al. *Amanitaceae India*: 68. 1990. [Accepted name?] **L**: Himachal Pradesh: Shimla, Taradevi (Kumar *et al*, 1990*a*). **R**: We hesitate to declare this name accepted because more taxonomic data on this and related species are needed.

23. *Amanita gemmata* (Fr.) Bertillon *in* Dechambre. *Dict. Encycl. Sci. Medic.* 1 (3): 496. 1866. [Accepted name] **L**: Himachal Pradesh: Shimla, Summer Hill and Glen (Bhatt *et al.*, 1988); Taradevi, Baghi, Jubbal and Chopal (Kumar *et al.*, 1990*a*; 1990*b*). **R**: This European species is not known to be exportable with symbionts. The name is applied loosely to white, tan, yellow-orange and yellowish species of *Amanita* section *Amanita* around the world. One entity commonly called *A. gemmata* in eastern Asia has recently been recognized as a distinct species [*A. orientigemmata*], and its original description is a very good match to the description of "*A. gemmata*" by Kumar *et al.* (1990*a*). We propose that the new name is the correct one for the material described by Kumar *et al.* It now seems unlikely that *A. gemmata* would occur in India. Indian material previously determined as this species should be revised. See the discussion of *A. albocreata*, above.

24. *Amanita hemibapha* (Berk. & Broome.) Sacc. *Syll. Fung.* **5**: 13. 1887. [Accepted name] **L**: Assam: Khasi Hills (Berkeley, 1852 as *Agaricus caesareus* Scop.). Uttaranchal: Dehradun (Bakshi, 1974). Himachal Pradesh: Shimla, Shillaroo, Narkanda, Baghi, Khadrala; Kullu, Pulga, Manali; Chamba and Khajjiyar (Kumar *et al.*, 1990*a* and 1990*b* as *Amanita caesarea* (Scop.:Fr.) Pers. **R**: The name *A. caesarea sensu auct.* has often been applied to this taxon. But that name has also been applied to numerous other taxa of *Amanita* stirps *Hemibapha* (Tulloss, 1998a). Therefore, one cannot simply make a substitution of "*hemibapha*" for "*caesarea*" when reviewing the literature. Southern and southeast Asia apparently comprise a center of speciation for the taxa of stirps *Hemibapha*, with a variety of spore shapes and sizes, habits and colors of the basidiome, and bruising reactions of the basidiome combining to identify taxa that apparently do not intergrade. These are interpreted by some authors as distinct species, by others as subspecies of *A. hemibapha*, and by others as varieties of *A. hemibapha*. Among the taxa to which the names "*A. caesarea*" and "*A. hemibapha*" may be misapplied are *A. caesareoides*, *A. chepangiana* Tulloss & Bhandary, *A. javanica* (below), *A. pakistanica* Tulloss, S. H. Iqbal & A. N. Khalid, *A. hemibapha* var. *ochracea* Zhu L. Yang, *A. similis* Boedijn, and *A. simlensis* (below)—as well as possibly new taxa. *Amanita caesareoides* conforms very well to the description of *A. caesarea* by Kumar et al. (1990*a*) as suggested by Tulloss (1998*a*).

25. *Amanita indica* R. P. Bhatt, Locq. & T. N. Lakh. *in* Kumar et al. *Amanitaceae India*: 71. 1990. [Not accepted, posterior synonym] **L**: Himachal Pradesh: Shimla, Taradevi, Jakhoo, Baghi (Kumar *et al.*, 1990*a*). **R**: According to our revisions, this name is a posterior taxonomic synonym of *A. pseudoporphyria* Hongo.

26. *Amanita javanica* (Corner & Bas) T. Oda, C. Tanaka & Tsuda. *Mycoscience* 40: 64. 1999. [Accepted name] **L**: Orissa: Phulbani, Daringbadi (Dhancholia, 1989); Keonjhar, Kiriburu (Das and Sinha, 1990). **R**: The more familiar combination is *A. hemibapha* subsp. *javanica* Corner & Bas (1962). See the entry regarding *A. hemibapha*, above. The species described by Dhancholia and by Das and Sinha has a yellow rather than orange-buff annulus, and neither paper mentions orange fibrils or felted fragments on the stipe, which are present in *A. javanica*.

27. *Amanita konkanensis* A. V. Sathe & S. M. Kulk. *in* S. M. Kulk. *Biovigyanam* 18 (1): 56-58. 1992. [Accepted name] **L**: Maharashtra: Sawantwadi (Kulkarni, 1992). **R**: This species was described originally from Maharashtra State and is apparently known only from the type locality.

28. *Amanita multisquamosa* Peck. *Rep. (Annual) Regents Univ. State New York New York State Mus. Nat. Hist.* 53: 840, pl. B, figs. 1-7. 1900. [Accepted name] **L**: Himachal Pradesh: Sirmour, Pacchad, Mohan (Saini and Atri, 1993). **R**: This species is known only from eastern North America. It is very unlikely to occur in India. Indian collections of this taxon should be revised. Jenkins (1977) created the combination *Amanita pantherina* var. *multisquamosa* (Peck) Dav. T. Jenkins. A posterior synonym of the present name that is commonly seen in the literature is *A. cothurnata* G. F. Atk.

29. *Amanita muscaria* subsp. *muscaria* [Conserved name] **L**: Tamil Nadu: Kodaikanal (Sathe and Sasangan, 1977); Kodaikanal, Guntur (Natarajan, 1977). Jammu and Kashmir: Kashmir, Sonamarg (Watling and Gregory, 1980). **R**: Indian material determined as this species (especially from southern India) should be revised because of the similarity of the species to *A. bharatensis* (above).

30. *Amanita muscaria* subsp. *flavivolvata* Singer. *Sydowia* 11: 374. 1958. [Accepted name] **L**: Himachal Pradesh: Shimla, Narkanda, Hatoo Peak (Kumar *et al.*, 1990*a*; 1990*b*). **R**: This is a common species in North and Central America, but (unless exported with a mesoamerican *Quercus* or a North American conifer) it is unlikely to be found in India. It is often identified using the combination *A. muscaria* var. *flavivolvata* (Singer) Dav. T. Jenkins. To date, all the Indian material determined as this subspecies revised by us has proven to be *A. rubrovolvata* S. Imai, which is reported herein for the first time from India. Revision of additional collections is continuing.

31. *Amanita orsonii* A. Kumar & T. N. Lakh. *in* Kumar et al. *Amanitaceae India*:. 75. 1990. [Accepted name] **L**: Himachal Pradesh: Kullu, Manali, Pulga; Chamba, Kala Top (Kumar *et al.*, 1990*a*); Shimla, Baghi (Tulloss *et al.*, 2001). Uttaranchal: Chamoli, Bhatwari Garhwal (Tulloss *et al.*, 2001). **R**: This species appears to be the "*A. rubescens*" of Pakistan, northern India, and Japan (Tulloss *et al.*, 2001). (See *A. rubescens*, below.)

32. *Amanita ovalispora* Boedijn. *Sydowia* 5: 320. 1951. [Accepted name] **L**: Orissa: Phulbani, Daringbadi (Dhancholia, 1989); Koraput, Nawrangpura (Das and Sinha, 1990). **R**: Dhancholia's material differs from *A. ovalispora* in the color of the pileus, a friable rather than membranous universal veil, and spores that are apparently more broadly ellipsoid than ellipsoid. The material described by Das and Sinha also differs from *A. ovalispora* in pileus color. It is also odd that their reported lower limit of spore width is reported as equal to what appears to be the average spore width; in turn, this contributes to a high value of average Q for the material (1.5). Z. L. Yang (1997) reported the spores from Boedijn's type were (8.0-) 8.5 - 10.0 (-10.5) × (6.0-) 6.5 - 7.5 (-8.0) µm, (Q = (1.19-) 1.25 - 1.42 (-1.47); **Q'** = 1.32±0.06). Revision of the material of Dhancholia and Das and Sinha would be valuable.

33. *Amanita pachycolea* Stuntz *in* Thiers & Ammirati. *Mycotaxon* 15: 158-161. 1982. [Accepted name] **L**: Uttaranchal: Garhwal, Khirsu (Bhatt *et al.*, 1999). **R**: This species is known from the Pacific Coast of the United States (California, Oregon and Washington) its occurrence in India is problematic. Material from India previously determined as this species should be re-examined. Based on (Tulloss *et al.*, 2001), it is possible that such material could belong in *A. umbrinolutea* (Secr. *ex* Gillet) Bataille. Indeed, we have recently revised material from Himachal Pradesh that proved to be *A. umbrinolutea*.

34. *Amanita pantherina* (DC.:Fr.) Krombh. *Naturgetreue Abbild. Essbar. Schädl. Und-verd. Schwäm.* 4: 24, pl. 29. 1836. [Accepted name] **L**: Tamil Nadu: Kodaikanal (Sathe and Sasangan, 1977). Jammu and Kashmir: Kashmir, Gulmarg (Watling and Gregory, 1980), Pahalgam (Abraham and Kachroo, 1989). Himachal Pradesh: Shimla, Narkanda, Charabara, Shillaroo, Baghi, Jubbal, Khara Pathar, Chopal and Churdhar; Kullu, Pulga and Manali; Chamba, Kala Top and Khajjiyar (Kumar *et al.*, 1990*a*). Meghalaya: Khasi Hills, Shella, and Shillong, (Shajahan *et al.*, 1988). **R**: There is no confirmed case of this European and western Asian species being exported with a symbiont. Z. L. Yang has reported and described several pantherinoid taxa from China and Japan including, e.g., *A. pantherina* var. *lutea*, *A. pseudopantherina* Zhu L. Yang *nom. prov.*, and *A. subglobosa*. Indian material previously determined as *A. pantherina* should be revised.

35. *Amanita peckiana* Kauffman *in* Peck. *Mycologia* 5: 67. 1913. [Accepted name] **L**: Uttaranchal: Garhwal, Danadapani (Bhatt *et al.*, 1999). **R**: This species is known only from eastern North America. Additional study of the Indian material determined originally as this species has indicated that it should be referred to *Amanita clarisquamosa* (S. Imai) E. J. Gilbert.

36. *Amanita phalloides* (Fr.:Fr.) Link. *Handb. Erkenn. nutzb. hänfigst. Gewächse* 3: 272. [Accepted name] **L**: Uttaranchal: Almora (Dhancholia, *et al.*, 1991); Garhwal, Kuinkaleshwar, Nagdev-Jhandidhar (Bhatt *et al.*, 1999). Meghalaya: West Khasi Hills (Rao *et al.*, 1997). **R**: Like *A. muscaria*, there are instances in which this species has been exported along with a variety of symbionts, which would make its occurrence in India possible. Unfortunately, Dhancholia, *et al.* (1991) provided no taxonomic data regarding their collection. Some Uttaranchal material determined originally as this species was revised by us and proved to be *A. subjunquillea* S. Imai var. *subjunquillea*.

37. *Amanita porphyria* (Alb. & Schwein.: Fr.) Alb. & Schwein. *Consp. Fung.*: 142, taf. 11 (fig. 1). 1815. [Accepted name] **L**: Uttaranchal: Pithoragarh, Thal Kedar (Adhikari and Bora, 1989). **R**: This species apparently is one of the few amanitas that has a circumboreal distribution; however, there may be more than one species to which the name is commonly given in North America and Europe. The presence of *A. pseudoporphyria* (see *A. indica*, above) in India raises the possibility that at least some Indian material determined as *A. porphyria* may be misdetermined. We regard the occurrence of *A. porphyria* in India as requiring further study.

38. *Amanita regalis* (Fr.:Fr.) Michael. 1903. *Führer Pilzfreunde*, 4th ed. 1: pl. 56. [Accepted name] **L**: Uttaranchal: Garhwal, Jaiharikhal (Bhatt *et al.*, 1999). **R**: This species is treated as *A. muscaria* var. *regalis* (Fr.:Fr.) E. J. Gilbert by some authors, but this

assignment of rank is becoming uncommon in Europe. In countries in which the species is well known (e.g., in Scandinavia), species rank is apparently universally accepted. (See *A. emilii*, above.)

39. *Amanita rubescens* (Pers.:Fr.) Pers. *Tentam. Disp. Meth. Fung.*: 67. 1794. [Accepted name] **L**: Meghalaya: Khasi Hills, Shella, and Shillong, (Shajahan *et al.*, 1988). Himachal Pradesh: Shimla, Summer Hill, Taradevi and Jakhoo (Bhatt and Lakhanpal, 1989); Shimla, Baghi, Charabara, Narkanda and Kullu, Pulga (Kumar *et al.*, 1990*a*; 1990*b*). Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: This species has been found to be exported in association with symbionts (Tulloss, unpub. data); however, Indian material determined originally as *A. rubescens* that has been revised by Tulloss has proven to be *A. orsonii* (Tulloss *et al.*, 2001) except for a single case in which the material proved to be *A. fritillaria*. The report of Shajahan *et al.* (1988) describes something with extremely small spores that may not be an *Amanita*.

40. *Amanita sampajensis* A. V. Sathe & S. M. Kulk. *MACS Monograph* 1: 44. 1980. [Accepted name] **L**: Maharashtra: Sampaje (Sathe and Kulkarni, 1980). **R**: This species was described originally from India and is apparently known only from its type locality.

41. *Amanita simlensis* R. P. Bhatt, Locq. & T. N. Lakh. *in* Kumar et al. *Amanitaceae India*: 85. 1990. [Accepted name.] **L**: Himachal Pradesh: Shimla, Hatoo Peak (Kumar *et al.*, 1990*a*). **R**: This species was described originally from India. It has only been reported from its type locality.

42. *Amanita solitaria* (Bull.:Fr.) Mérat. 1836. *Nouv. Fl. Envir. Paris*, 4^{me} ed. 1: 121. [Accepted name] **L**: Rajasthan: Udaipur (Doshi and Sharma, 1997 as *A. echinocephala* (Vitt.) Quél., a synonym *per* Bas (1969)). Kerala: (Devi and Nair, 1983, as cited in Purkayastha and Chandra, 1985). **R**: This species has been reported from many places outside of Europe and adjacent western Asia; but, to date, the relevant collections eventually have been found to be indigenous taxa (e.g., by Bas (1969)). It is unlikely that the species would be found in India.

43. *Amanita subvaginata* (Cleland & Cheel) E. J. Gilbert. *Iconogr. Mycol. (Milan)* 27 suppl. (2): 206. 1941. [Accepted name] **L**: Orissa: Phulbani, Kalinga (Dhancholia, 1989). **R**: The numerous species Cleland described from South Australia are unusual in their relative phenetic isolation from other taxa of *Amanita*. It seems unlikely that one of these species would have a disjunct distribution outside of Australia. Moreover, the Australian species is assignable to *Amanita* section *Amanita* and is somewhat similar to *A. farinosa* of North America, whereas Dhancholia describes and illustrates a species of *Amanita* section *Vaginatae* with a saccate universal veil. The macroscopic description of this species suggests *A. pseudovaginata*; however, the spore size and shape is too round and too small. This difference could be explained by the spores not having been measured in strictly lateral view. Indian material determined as *A. subvaginata* should be revised.

44. *Amanita vaginata* (Bull.:Fr.) Lam. *Encycl. Méthod. Bot.* 1: 109. 1783 ["1784"]. [Accepted name] **L**: Assam: Khasi Hills (Berkeley, 1852 as *Agaricus*). Himachal

Pradesh: Solan (Sohi *et al.*, 1964 and Tilak and Rao, 1968); Shimla, Chadwick Fall, Potters Hill, Glen, Narkanda, Baghi, Khara Pathar, Kullu, Manali, Chamba and Kala Top (Kumar *et al.*, 1990*a*; 1990*b*). Maharashtra: Nagpur (Trivedi, 1972). Uttar Pradesh: Lucknow (Ghosh *et al.*, 1974); Allahabad (Singh and Mehrotra, 1974). West Bengal: Bankura (Ray and Samajpati, 1979). Jammu and Kashmir: Kashmir, Pahalgam (Abraham and Kachroo, 1989), Sarband near Harwan (Watling and Gregory, 1980). Meghalaya: Khasi Hills, Shella and Shillong (Shajahan *et al.*, 1988 [as *Amanitopsis vaginata*]. **R**: The name "*vaginata*" has been applied very loosely all over the world. It is most often applied in cases of a species with a gray to grayish brown or brownish gray pileus; however, the name has been applied to many other exannulate taxa of *Amanita* section *Vaginatae*. At least two taxa have been distinguished in the process of revising Indian material determined originally as *A. vaginata* (Tulloss *et al.*, 2001): *A. pseudovaginata* Hongo and an apparently undescribed species also treated as *A. vaginata* by Kumar *et al.* (1990*a*). Occasionally, the two taxa are found mixed in a single collection. Critical revision of Indian material determined as *A. vaginata* is needed.

45. *Amanita velatipes* G. F. Atk. *Studies Amer. Fung.*: 63, figs. 64-67. 1900. [Accepted name] **L**: Himachal Pradesh: Shimla, Chajpur (Kumar *et al.*, 1990*a*). **R**: This species may be found in some literature under the combination *A. pantherina* var. *velatipes* (G. F. Atk.) Dav. T. Jenkins. It is a species known only from eastern North America and is unlikely to be collected in India. Indian material determined as this species that has been revised by us proved to be *A. pantherina* var. *lutea* W. F. Chiu previously known only from Yunnan Prov., China, and recently provided with a detailed modern description by Yang (1997).

46. *Amanita verna* (Bull.:Fr.) Lam. *Encycl. Méthod. Bot.* 1 (1): 113. 1783. [Accepted name] **L**: Maharashtra: Nagpur (Trivedi, 1972). Uttaranchal: Dehradun, Asarori, Jadhiwala and Jhagra, FRI (Bakshi, 1974). Orissa: Phulbani, Kalinga (Dhancholia, 1989). Rajasthan: Udaipur (Doshi and Sharma, 1997). **R**: There is some difficulty regarding the taxonomy of this species, even in Europe. It is often reported that the species is nonreactive with KOH solution in contrast to *A. virosa*; however, a concerted effort to find nonreactive "*verna*" in southern Europe has produced only reactive (yellowing) basidiomes (F. Massart, pers. corresp.). At any rate, there is no evidence that *A. verna* can be exported from Europe and western Asia with symbionts. A more likely determination of a white Indian species in *Amanita* section *Phalloideae* bearing ellipsoid spores might be *Amanita oberwinklerana* Zhu L. Yang & Yoshim. Doi (1999) [see also (Yang, Li and Wu, 2001)]; and, indeed, we found an Indian collection of this species during our process of revision. Dhancholia's material assigned to *A. verna* has two-spored basidia, and his description strongly suggests *A. exitialis* Zhu L. Yang & T. H. Li (2001). Indian material previously determined as *A. verna* should be revised.

47. *Amanita virosa* (Fr.) Bertillon *in* Dechambre. *Dict. Encycl. Sci. Medic.* 1 (3): 497. 1866. [Accepted name] **L**: Uttaranchal: Garhwal, Kuinkaleshwar (Bhatt *et al.*, 1999). **R**: Material from Uttaranchal that was determined originally as *A. virosa* was revised by us and proved to be *Amanita subjunquillea* var. *alba* Zhu L. Yang (1997). In the future,

if material is collected with globose to subglobose spores between 9.5 and 12 µm long (as *is* to be found in material deposited in GUH), then a determination as *A. exitialis* should be considered.

48. *Amanita vittadinii* (Moretti) Vitt. *Tent. Mycol. Amanita* 3: 31, pl. I. 1826. [Accepted name] **L**: Jammu and Kashmir: Kashmir, Gulmarg (Abraham and Kachroo, 1989; Pandotra, 1997). **R**: Despite claims to the contrary, we know of no evidence that this white to whitish species occurs outside of Europe and adjacent western Asia. In their report of this species, Abraham and Kachroo (1989) describe a yellow species with spores much larger than those of any known macroscopically similar southern or eastern Asian species of *Amanita* subsection *Vittadiniae* Bas. Their illustrations of spores from their material are unusual for *Amanita* spores. The single collection is in need of revision.

49. *Amanita volvata* (Peck) Lloyd. *Mycol. Writings I (Volvae)*. **9**: 15. 1898. [Accepted name] **L**: Himachal Pradesh: Shimla, Narkanda, Hatoo Peak (Kumar *et al.*, 1990*a*; 1990*b*). **R**: The Indian material determined as *A. volvata* that has been revised by us to date is assignable to *A. avellaneosquamosa* (S. Imai) S. Imai.

50. *Amanita watlingii* A. Kumar & T. N. Lakh. *in* Kumar et al. *Amanitaceae India*: 92. 1990. [Not accepted, posterior synonym] **L**: Himachal Pradesh: Kullu, Pulga; Shimla, Chopal (Kumar *et al.*, 1990*a*). **R**: As proposed by Tulloss *et al.* (2001), this name is a posterior synonym of *A. flavipes*. (See *A. flavoconia*, above.)

Genus: *Limacella* Earle. *Bull. N. Y. Bot. Gard.* 5: 447. 1909.
Type species: *Agaricus delicatus* Pers.:Fr. 1821. *Syst. Mycol.* 1: 27.

51. *Limacella quilonensis* A. V. Sathe & Jeys. Daniel. *MACS Monograph 1*: 85. 1980. [Accepted name?] **L**: Kerala: Quilonia (Sathe and Daniel, 1980). **R**: This species was described originally from India.

52. *Limacella guttata* (Pers.:Fr.) Konrad & Maubl. *Icon. Sel. Fung.* 1: pl. 9. 1924. [Accepted name] **L**: West Bengal: Calcutta (Roy and Samajpati, 1978).

53. *Limacella sp.* **L**: Orissa: (Rath, 1978).

DISCUSSION

Our review indicates that many names in the list have been or may have been misapplied. We suggest possible alternate determinations in the case of about 60% of the *Amanita* names in the list.

The 22 names that we have demonstrated to be at least occasionally misapplied (or that are posterior synonyms) and their correlated corrections based on our redeterminations are provided in Table 1. We caution that it cannot be assumed that all applications of a given misapplied name correlate to the same Indian taxon. An "n" superscript on a name in Table 1 indicates a new record for India. An equal sign in parentheses in Table 1 indicates the name is a posterior taxonomic synonym of the corresponding name in the column to the immediate right. There are 22 taxa listed in Table 1 as redeterminations. We believe there is at least one unnamed candidate to consider when revising material determined in the past as *A. ceciliae*, *A. cokeri*, *A. hemibapha*, or *A. vaginata*. *Amanita berkeleyi* is listed among the names correctly applied in the region of study. Hence, there is a minimum of 25 distinct taxa belonging solely to the group represented in Table 1.

Name in List	Redetermination(s)	Name in List	Redetermination(s)
albocreata	*orientigemmata*^{n}	*pachycolea*	*umbrinolutea*^{n}
berkeleyi	*berkeleyi* & *fritillaria*	*pantherina* var. *velatipes*	*pantherina* var. *lutea*^{n}
caesarea	Diverse spp. of *Amanita* stirps *Hemibapha* including *caesareoides*^{n}, *hemibapha, javanica, similis, simlensis,* etc.	*peckiana*	*clarisquamosa*^{n}
calyptratoides	Sp. of sect. *Vaginatae* or sect. *Phalloideae*	*phalloides*	*subjunquillea* var. *subjunquillea*^{n}
ceciliae	Spp. of sect. *Vaginatae* (at least 3) including *liquii*^{n} and *umbrinolutea*^{n}	*rubescens*	*orsonii* and, infrequently, *fritillaria*
cokeri	Spp. of sects. *Amanita* and *Lepidella* including *concentrica*^{n}	*subvaginata*	Sp. of sect. *Vaginatae*, possibly *pseudovaginata*
elata	Sp. of sect. *Phalloideae* or sect. *Vaginatae*	*vaginata*	Several spp. Including *pseudovaginata*^{n}
flavoconia	*flavipes*	*verna*	At least two spp. including *exitialis*^{n} & *oberwinklerana*^{n}
gemmata	*orientigemmata*^{n}	*virosa*	At least two spp. including *exitialis*^{n} & *subjunquillea var. alba*^{n}
indica (=)	*pseudoporphyria*^{n}	*volvata*	*avellaneosquamosa*^{n}
muscaria subsp. *flavivolvata*	*rubrovolvata*^{n}	*watlingii* (=)	*flavipes*

Table 1: Names known to have been misapplied to Indian species of *Amanita* with proposed correct determinations *and* names of posterior synonyms (indicated by "(=)") applied to Indian species of *Amanita* with accepted correct names for the taxa.

Names possibly misapplied with corresponding possible corrections to determination suggested for further research are presented in Table 2. The columns headed "Possible Redetermination(s)" include names that have not been demonstrated to be correctly applied to any material determined originally under the name in the column immediately to the left, but might prove to be correct redeterminations. There are 11 checklist names that are treated in Table 2. We believe that they have been applied to as many as 15 or more taxa of which 6 are distinct from those whose application is not questioned in this paper (*A. eriophora* is not questioned as its type collection is from India.) and those listed in Table 1.

The number of names in the list that are both accepted as correct and are possibly or certainly correctly applied to Indian material is 15. Two pairs of these names may be synonyms; therefore, conservatively, the list of correctly or possibly correctly applied names includes 13 taxa. Hence, our brief and preliminary analysis suggests that the number of

Amanita taxa in India is at least (25+11+13) 49—accounting for known misapplication and known synonymy. Because of the lack of names available for taxa in *Amanita* section *Vaginatae* alone, we believe that the eventual number of Indian amanitas recorded will certainly be greater.

Given the limited work on Indian agarics cited at the outset of this paper, the increasing number of taxa from northern India that were originally described from China and Japan (with a total of over 80 *Amanita* taxa known between them), the diversity of habitat presented by the Indian subcontinent, and the number of potentially novel taxa in our respective herbaria, it is possible that the number of species of *Amanita* in India will be in the range of 80 to 100, or even greater.

Name in Checklist	**Possible Redetermination(s)**	**Name in Checklist**	**Possible Redetermination(s)**
citrina	*sinocitrina*	*fulva*	Spp. of *Amanita* sect. *Vaginatae* including *orientifulva*
craseoderma	?	*multisquamosa*	?
emilii	*subglobosa*	*pantherina*	*subglobosa*
eriophora	*eriophora* & ?	*porphyria*	*pseudoporphyria, sinocitrina*
excelsa	Spp. of *Amanita* sect. *Validae* (Fr.) Quél. including *fritillaria, orsonii, & sepiacea*	*solitaria*	?
farinosa	*sinensis* var. *sinensis,* *sinensis* var. *subglobispora,* *farinosa sensu auct. Asia orient.*	*vittadinii*	?
franchetii	?		

Table 2: Names from the checklist that are possibly misapplied to Indian taxa with possible lists of correct names for those taxa.

Our tentative revision of the list of amanitas in India (including 39 taxa) follows—organized alphabetically by section:

- section *Amanita* (7 or 8 taxa): *bharatensis* (instead, could be in section *Validae*), *concentrica*, *emilii sensu* A. Kumar *et al.*, *farinosa sensu auct. Asia orient.*, *muscaria* var. *muscaria*, *orientigemmata*, *pantherina sensu* Abraham and Kachroo, *pantherina* var. *lutea*
- section *Vaginatae* (14 taxa): *aporema*, *caesareoides*, *ceciliae sensu* Abraham and Kachroo, *fulva sensu* A. Kumar *et al.*, *hemibapha*, *hemibapha sensu* Zhu L. Yang, *javanica*, *liquii*, *ovalispora sensu* Zhu L. Yang, *pseudovaginata*, *sampajensis*, *simlensis*, *vaginata sensu* A. Kumar *et al.* (excluding *A. pseudovaginata*), *umbrinolutea*
- section *Amidella* (2 taxa): *avellaneosquamosa*, *clarisquamosa*
- section *Lepidella* (5 taxa): *alboflocossa*, *berkeleyi*, *eriophora*, *flavofloccosa sensu* Purushothama and Natarajan, *konkanensis*
- section *Phalloideae* (5 taxa): *exitialis*, *oberwinklerana*, *pseudoporphyria*, *subjunquillea* var. *alba*, *subjunquillea* var. *subjunquillea*

- section *Validae* (5 or 6 taxa): *bharatensis* (instead, could be in section *Amanita*), *flavipes*, *fritillaria*, *fritillaria sensu* A. Kumar *et al.*, *fulvaurantia*, *orsonii*.

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LITERATURE CITED

Abraham, S. P. and J. L. Kachroo. 1989. Larger fungi from Kashmir, India, VI. The genus *Amanita*. *Micol. Neotrop. Apl.* 2: 41-51.

Adhikari, R. S. and S. S. Bora. 1989. *Amanita porphyria*—A new record for India. *Curr. Sci.* 58: 90-91.

Bakshi, B. K. 1974. *Mycorrhiza and its role in forestry.* Forest Research Institute, Dehra Dun.

Bas, C. 1969. Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. *Persoonia* 5: 285-579.

Bas, C. 1984. On the correct name of "*Amanita inaurata* Secr." *Persoonia* 12: 192-193.

Bas, C. 2000. Una visione più ampia sulle *Amanita*. *Boll. Gruppo Micol. G. Bresadola* 43(2): 9-12.

Berkeley, M. J. 1850. Decades XXV to XXX. Sikkim-Himalayan fungi, collected by Dr. J. D. Hooker. *Hooker J. Bot. Kew Gard. Misc.* 2: 42-51, 76-88.

Berkeley, M. J. 1852. Decades XXXIX, XL. Sikkim and Khassya fungi. *Hooker J. Bot. Kew Gard. Misc.* 4: 130-142.

Bhatt, R. P. and V. K. Bhatt 1996. *Amanita cokeri* (Gilb. & Kühner) Gilbert—An addition to Indian Agarics. *Indian J. Mycol. Pl. Pathol.* 26(1): 113-114.

Bhatt, R. P., A. Kumar and T. N. Lakhanpal. 1988. Fleshy fungi of North-Western Himalayas—VII. *Indian J. Mycol. Pl. Pathol.* 18: 143-148.

Bhatt, R. P. and T. N. Lakhanpal. 1988. *Amanita fulva* (Schaeff. ex Pers.)—an edible mushroom new to India. *Curr. Sci.* 57: 1126-1127.

Bhatt, R. P. and T. N. Lakhanpal. 1989. A new record of edible *Amanita* from India. *Curr. Sci.* 58: 627-628.

Bhatt, V. K., R. P. Bhatt, R. D. Gaur and M. P. Singh. 1999. Mushrooms of Garhwal Himalaya: The genus *Amanita* Pers. ex Hooker. *Mushr. Res.* 8(2): 1-8.

Bilgrami, K. S., S. Jamaluddin and M. A. Rizwi. 1979. *Fungi of India. Part-I: List and References*. Today and Tomorrow's Printers and Publishers, New Delhi.

Bilgrami, K. S. 1991. *Fungi of India List and References*. Today and Tomorrow's Printers and Publishers, New Delhi.

Butler, E. J. and G. R. Bisby. 1931. Fungi of India. *Sci. Monogr. Imp. Council Agric. Res. India* 1: i-xviii, 1-237.

Chen, Z. H., Z. L. Yang and Z. G. Zhang. 2001. Three noteworthy *Amanitae* of subgenus *Lepidella* from China. *Mycotaxon* 79: 275-284.

Corner, E. J. H. and C. Bas. 1962. The genus *Amanita* in Singapore & Malaya. *Persoonia* 2: 241-304.

Das, M. K. and M. P. Sinha. 1990. Agaricales of Eastern India—I. *Indian Phytopath.* 43(2): 150-155.

Dhancholia, S. 1989. Noteworthy records of the genus *Amanita* from Orissa (India). *Acta Bot. Indica* 17: 279-282.

Dhancholia, S., J. C. Bhatt and S. K. Pant. 1991. Studies of some Himalayan Agarics. *Acta Bot. Indica* 19(1): 104-109.

Doshi, A. and S. S. Sharma. (1997). Wild Mushrooms of Rajasthan, *in*: Rai R. D., B. L. Dhar and R. N. Verma, eds. *Advances in Mushroom Biology and Production.* (Mushroom Society of India, National Research Center for Mushrooms, Chambaghat, Solan): 105-127.

Ghosh, R. N., N. C. Pathak and B. P. Singh. 1974. Studies on Indian Agaricales II. *Proc. Nat. Acad. Sci. India* 44:125-128.

Gilbert, E. J. 1918. *Le genre Amanita Pers.* (Lons-le Saunier). 186 pp.

Gilbert, E. J. 1940-41. Amanitaceae. *Iconogr. Mycol. (Milan)* 27 suppl. (1-3): i-xx, 1-427, pl. 1-73.

Heim, R. 1934. Fungi Iberici I. Observations sur la flore mycologique catalane. *Treb. Mus. Ciénc. Natur. Barcelona* 15(3): 1-146.

Holmgren, P. K., N. H. Holmgren and L. C. Barnett. 1990. Index herbariorum. Part I. The herbaria of the world, 8th ed. *Regnum Veg.* 120: 1-693.

Jenkins, D. T. 1986. *Amanita of North America*. (Mad River Press, Inc. Eureka). 198 pp.

Kaur, A. and N. S. Atri. 2002. Some interesting mushrooms from Punjab plains. *Mushr. Res.* 11(1): 1-5.

Kirk, P. M. and A. E. Ansell. 1992. Authors of fungal names. *Index Fung., Suppl.*: i-viii, 1-95.

Kulkarni, S. M. 1992. *Amanita konkanensis*: a new species of Agaricales. *Biovigyanam* 18(1): 56-58.

Kumar, A., R. P. Bhatt, and T. N. Lakhanpal. 1990*a*. *The Amanitaceae of India*. (Bishen Singh Mehendra Pal Singh Publication, Dehra Dun). 160 pp.

Kumar, A., T. N. Lakhanpal, and S. L. Stephenson. 1990*b*. Ecological studies of some macrofungi in the northwestern Himalayas. *Nova Hedwigia* 50: 535-547.

Manjula, B. 1983. A revised list of the agaricoid and boletoid basidiomycetes from India and Nepal. *Proc. Indian Acad. Sci. (Plant Sci.)* 92: 81-231.

Nagasawa, E. and T. Hongo. 1984. New taxa of *Amanita*: Three new species and one new form from western Japan. *Trans. Mycol. Soc. Japan* 25: 367-376.

Natarajan, K. 1977. South Indian Agaricales. III. *Kavaka* 5: 35-39.

Natarajan, K. and K. B. Purushothama. 1987. South Indian Agaricales. XXIII. *Kavaka* 15: 75-86.

Oda, T., C. Tanaka and M. Tsuda. 1999. Molecular phylogeny of Japanese *Amanita* species based on nucleotide sequences of the internal transcribed spacer region of nuclear ribosomal DNA. *Mycoscience* 40: 57-64.

Oda, T., C. Tanaka and M. Tsuda. 2002 *Amanita concentrica*: a new species in *Amanita* section *Amanita* in Japan. *Mycoscience* 43: 81-83.

Pandotra, V. R. 1997. *Illustrated fungi of north India with special reference to J. and K. State*. International Book Distributors, Dehra Dun.

Pouzar, Z. 1983. Taxonomic and nomenclatural notes on some families of larger fungi. *Česká Mykol.* 37: 172-176.

Purkayastha, R. P. and A. Chandra. 1985. *Manual of Indian Edible Mushrooms.* Today and Tomorrow's Printers and Publishers, New Delhi.

Purushothama, K. B. and K. Natarajan. 1987. *Amanita flavofloccosa*—an addition to Indian agaric flora. *Curr. Sci.* 56:1073-1074.

Rao, C. S., G. D. Sharma and A. K. Shukla. 1997. Distribution of mycorrhizal fungi in pure stands of different age groups of *Pinus kesiya*. *Canad. J. Microbiol.* 43: 85-91.

Rath, G. C. 1978. Mushroom cultivation in Orissa. *Indian Mushr. Sci.* 1: 41-48.

Ray, S. and N. Samajpati. 1979. Agaricales of West Bengal IV. *Indian J. Mycol. Res.* 17: 65-69.

Roy, A. and N. Samajpati. 1978. Agaricales of West Bengal II. *Indian J. Mushr.* 4(2): 17-23.

Roze, E. 1876*a*. Essai d'une nouvelle classification des Agaricinées. *Bull. Soc. Bot. France* 23: 45-52.

Roze, E. 1876*b*. Catalogue des Agaricinées observées aux environs de Paris. *Bull. Soc. Bot. France* 23: 108-115.

Saini, S. S. and N. S. Atri. 1993. North Indian Agaricales—IV. *Indian J. Mycol. Pl. Pathol.* 23(3): 250-254.

Sarbhoy, A. K., J. L. Varshney and D. K. Agarwal. 1996. Fungi of India, 7th supplement (1982-1992). (CBS Publishers and Distributors, New Delhi).

Sathe, A. V. and J. Daniel. 1980. Agaricales (Mushrooms) of Kerala State *in Agaricales of south west India*. A. V. Sathe, S. Deshpande, S. M. Kulkarni and J. Daniel, eds. (Maharashtra Assoc. for the Cultivation of Science, Pune): 75-108.

Sathe, A. V. and S. D Deshpande. 1980. Agaricales (Mushrooms) of Maharashtra State *in Agaricales of south west India.* A. V. Sathe, S. Deshpande, S. M. Kulkarni and J. Daniel, eds. (Maharashtra Assoc. for the Cultivation of Science, Pune): 9-42.

Sathe, A. V. and S. M. Kulkarni. 1980. Agaricales (Mushrooms) of Karnataka State *in Agaricales of south west India.* A. V. Sathe, S. Deshpande, S. M. Kulkarni and J. Daniel, eds. (Maharashtra Assoc. for the Cultivation of Science, Pune): 43-73.

Sathe, A. V. and K. C. Sasangan. 1977. Agaricales from south-west India—III. *Biovigyanam* 3: 119-121.

Shajahan, Md., N. Roy Choudhury, A. K. Saha and N. Samajpati. 1988. Mushroom flora of Khasi (Meghalaya), India. *Indian J. Mycol. Res.* 26: 75-85.

Singer, R. 1986. *The Agaricales in Modern Taxonomy*, 4th ed. (Koeltz, Koenigstein). i-viii, 1-981, pl. 1-88.

Singh, J. and B. S. Mehrotra. 1974. A survey of the gilled mushrooms in India I. *Nova Hedwigia* 47: 511-529.

Sohi, H. S., S. Kumar and P. K. Seth. 1964. Some interesting fleshy fungi from Himachal Pradesh. *Indian Phytopath.* 17: 217-222.

Stafleu, F. A. *et al*. 1978. International code of botanical nomenclature. *Regnum Veg.* 97: 1-457.

Tilak, S. T. and R. Rao. 1968. *Second supplement to the fungi of India* (1962-67). (Marathawada Univ., Marathawada).

Trivedi, T. K. 1972. Agaricales of Nagpur—I. *Botanique (Nagpur)* 3: 53-59.

Tulloss, R. E. 1993. *Amanita pachysperma*, *Amanita subvirginiana*, and *Amanita virginiana* (taxonomy and distribution) with notes on the description of lamella trama in *Amanita*. *Mycotaxon* 49: 449-475.

Tulloss, R. E. 1994. Type studies in *Amanita* section *Vaginatae* I: Some taxa described in this Century (studies 1-23) with notes on description of spores and refractive hyphae in *Amanita*. *Mycotaxon* 52: 305-396.

Tulloss, R. E. 1998*a* ["1997"]. Provisional world key to species closely related to *Amanita hemibapha* with notes on the slender Caesar's mushrooms of eastern North America. *McIlvainea* 13(1): 46-53.

Tulloss, R. E. 1998*b*. *Syllabus for a seminar on Amanita*. (N. Amer. Mycol. Assoc. & Mycol. Soc. San Francisco). vi+184+ii pp.

Tulloss, R. E. 2000*a*. Le *Amanita* nel mondo: bellezza, pericolo e diversità. *Boll. Gruppo Micol. G. Bresadola* 43(2): 13-21

Tulloss, R. E. 2000*b*. Note sulla metodologia per lo studio del genere *Amanita* (Agaricales). *Boll. Gruppo Micol. G. Bresadola* 43(2): 41-59.

Tulloss, R. E, S. H. Iqbal, A. N. Khalid, R. P. Bhatt and V. K. Bhatt. 2001. Studies in *Amanita* (Amanitaceae) from southern Asia. I. Some species of Pakistan's Northwest Frontier Province. *Mycotaxon* 77: 455-490.

Tulloss, R. E, C. L. Ovrebo and R. E. Halling. 1992. Studies on *Amanita* (Amanitaceae) from Andean Colombia. *Mem. New York Bot. Gard.* 66: 1-46.

Vasudeva, R. S. 1960. *The fungi of India (revised)*. (ICAR, New Delhi).

Watling, R. and N. M. Gregory. 1980. Larger fungi from Kashmir. *Nova Hedwigia* 32: 493- 564.

Yang, Z. L. 1997. Die *Amanita*-Arten von Südwestchina. *Biblioth. Mycol.* 170: 1-240.

Yang, Z. L. 2002. *Amanita eijii*—a new name for *Amanita cokeri* f. *roseotincta*. *J. Jilin Agric. Univ.* 24(2): 32-34.

Yang, Z. L. and Y. Doi. 1999. A contribution to the knowledge of *Amanita* (Amanitaceae, Agaricales) in Japan. *Bull. Nat. Sci. Mus., Tokyo, Ser. B* 25(3): 107-130.

Yang, Z. L. and T. H. Li. 2001. Notes on three white *Amanitae* of section *Phalloideae* (Amanitaceae) from China. *Mycotaxon* 78: 439-448.

Yang, Z. L., T. H. Li and Z. L. Wu. 2001. Revision of *Amanita* collections made from Hainan, southern China. *Fung. Diversity* 6: 149-165.

Yang, Z. L. and F. Oberwinkler. 1999. Die Fruchtkörperentwicklung von *Amanita muscaria* (Basidiomycetes). *Nova Hedwigia* 68(3-4): 441-468.

Yang, Z. L., M. Weiss and F. Oberwinkler. to appear. New species of *Amanita* from eastern Himalayas and adjacent regions. *Mycologia*.

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THE AFFINITIES OF THYRIDARIA

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ABSTRACT: The varied dispositions of *Thyridaria* in the past are summarized. Important features of the genus are the presence of abundant subiculum surrounding ascomata, frequent occurrence of bright pigmentation in hyphae and ostioles, melanommatalean hamathecium and asci, and formation of wide, dark pachysepta and walls in ascospores. *Thyridaria* is assigned to the Didymosphaeriaceae; variations within and among the species in other genera of the family are noted. Two new species are presented, *T. arizonica* and *T. aurantiolutea*, and one new combination *T. maculans* is proposed.

KEYWORDS: Didymosphaeriaceae, Melanommatales, saprotrophic fungi, pachysepta

The genus *Thyridaria* Sacc. 1875 was based upon *T. incrustans* Sacc., a later synonym of *T. broussonetiae* (Sacc.) Trav. The concept of the genus includes species with ascomata grouped in various configurations in ample hyphal tomentum under the periderm or in old wood of woody plant substrates. The symmetric phragmospores form both thickened and darkened septa and walls. In these respects the species differ from those in *Melanomma* Nitschke ex Fuckel where the ascomata are typically superficial on the substrate and the phragmospores form thickened septa but thin walls. Members of both genera share similar melanommatalean features of trabeculate hamathecium and numerous peripherally arranged, cylindric or oblong and stipitate asci with a narrow endotunica and small apical ocular chamber.

The disposition of *Thyridaria* has varied over the years. Wehmeyer (1941) monographed the genus and compared it to *Melanomma* but did not assign either genus to family. *Thyridaria* has since been disposed within the broad concept of the Pleosporaceae (Munk 1957, Luttrell 1973, Wehmeyer 1975, Dennis 1978), although Müller and Arx (1973) included the genus within the Sphaeriaceae as an unitunicate taxon. Barr (1979) inserted *Thyridaria* into the Melanommataceae, and later (Barr 1987, 1990) into the Platystomaceae, a family name that must be returned again to synonymy under Lophiostomataceae. On the other hand, Cannon et al. (1985) and Eriksson (1992) indicated that its position was doubtful, as ?Dothideales, and Eriksson (1999) included *Thyridaria* under Dothidiomycetes inc. sed. as did Kirk et al. (2001).

Understanding of the true position of *Thyridaria* came only slowly to me. The salient features of the genus include the presence of frequently brightly pigmented hyphae, and the type of ascospore septum and wall. Configuration of ascomata and the amounts of surrounding hyphae may be quite varied within a species, as well as among species. The ascomata may be grouped in eutypelloid or in valsoid configuration in abundant hyphae, and become erumpent in groups through a hyphal disc or blackened periderm tissues. They may be separate beneath periderm (or epidermis) or in old wood, and each ascoma then is surrounded by a compact weft of hyphae. Less often the ascomata may be grouped and erumpent around and over other ascomycetes, as is the case in *T. minima* (Ellis & Everh.) Wehm.

The ascospores of all members of the genus form dark transverse septa and a thickened and darkened wall. The septa to me are neither distosepta nor are they eusepta, but what appear to be of an intermediate type that I treat as pachysepta (from Greek *pachys*, thick or stout). Immature ascospores show a narrow median transverse euseptum. Brown-pigmented granules are deposited along the transverse septum and inner wall. The results are strongly marked septa and a foveolate aspect to the wall. Similar pachysepta occur in the taxa of Melanommataceae, but the outer walls of the ascospores in that family are neither strongly thickened nor heavily pigmented as they are in *Thyridaria*. Pachysepta may be quite frequent in other families among species having strongly pigmented ascospores. Within the Lophiostomataceae (including the Platystomaceae) the septa in most genera are eusepta, although distosepta occur in a few taxa, and the outer ascospore walls are thin.

When immersed ascomata, abundant hyphal tomentum, and the ascospore characteristics described above are present in combination, the disposition of *Thyridaria* inevitably must be within the Didymosphaeriaceae Munk ss. Barr (1987, 1990). The phragmosporous position previously occupied by *Sporormiella* Ellis & Everh., when that genus is again arranged in the Sporormiaceae (Barr 2000), instead comfortably accepts *Thyridaria*. Most species of *Thyridaria* do not develop clypei over ascomata, as do certain species in *Didymosphaeria* Fuckel, where the clypeus often terminates as a hyphal weft. The tomentum in species of *Thyridaria* is comparable to that in the didymosporous *Pseudothyridaria insitiva* Petr., and in many collections of *Didymosphaeria oblitescens*(Berk. & Broome) Fuckel, although not necessarily in the type species *D. futilis* (Berk. & Broome) Rehm.

Karstenula rhodostoma (Alb. & Schwein.: Fr.) Speg. and several of its close relatives are similar in the presence of a rosy-pigmented ostiole and vinaceous-brown subiculum surrounding gregarious, papillate ascomata and in the symmetric dictyospores that are pachyseptate and thick walled. *Karstenula antiqua* (Ellis & Everh.) M.E. Barr and *K. pallida* (Ellis & Everh.) M.E. Barr form clypei over individual ascomata, whereas in *K. rousseliana* (Sacc. & Speg.) M.E. Barr, several ascomata in eutypelloid configuration develop under a blackened clypeus, and are in turn surrounded by dark brown hyphae. In *K. tuberculata* (Rehm) M.E. Barr, ascomata are individually surrounded by a tubercle of compact reddish brown hyphae. Incidentally, four large-spored species that Barr (1990) had assigned to *Karstenula* Speg. as *K. multiseptata* (Starb.) M.E. Barr, *K. rubelloides* (Plowr. ex Cooke) M.E. Barr, *K. rubicunda* (Niessl) M.E. Barr, and *K. straminis* (Sacc. & Speg.) M.E. Barr, appear to be pleosporalean and to belong in the Massarinaceae (Pleosporales).

The cleistothecioid genus *Neotestudina* Segretain & Destombes shows strong affinities in didymospores with other genera in the family, although the brittle, cephalothecoid peridium is another feature that separates this genus. *Roussoella* Sacc. with type species *R. hysterioides* (Ces.) Höhn. was arranged in the Didymosphaeriaceae (Ju et al. 1996) although Kirk et al. (2001) have it under the Xylariales. The ascospore wall is typically dark and conspicuously longitudinally striate; in this respect the genus fits well within the family. The species are not known to me, being in general inhabitants of bamboo culms and palm leaves in warm to tropical regions. An exception is known: Fallah and Shearer (2001) have described and illustrated from Wisconsin a collection of *R. intermedia* Y.M. Ju, J.D. Rogers & Huhndorf.

My reinterpretation of *Thyridaria* and its family position is established in the preceding remarks. The numbers of species accepted in the genus by Barr (1990) must be reduced by removal of the lophiostomataceous taxa, i.e., those with compressed papillae and hyaline to light brown, thin-walled ascospores. The species returned to *Lophiostoma* Ces. & DeNot. include *L. macrostomoides* DeNot., *L. magnatum* Cooke & Peck, *L. triseptatum* Peck, and *L. turritum* Cooke & Peck, all conforming to the broad concept of *Lophiostoma* set forth by Holm and Holm (1988). *Thyridaria eutypoides* Ellis & Everh., which forms thin-walled ascospores, is better regarded as a synonym of *Melanomma fuscidulum* Sacc. as Untereiner (1993) has done. Two undescribed species and one requiring transfer have come to my attention. The species that I know all form three-septate ascospores, and are separated in the following key. Validation of the taxa follows.

1.Ascospores short, 10-16(-19) µm long....................2
1.Ascospores longer, (12-)18-30 µm.........................6
2.Ascoma apices yellow to orange...........................3
2.Ascoma apices reddened to brown..........................4
3.Peridium brown beneath bright orange to yellowish hyphae...*T. aurantiolutea*
3.Peridium reddish brown beneath brown hyphae...*T. sambucina*
4.Ascoma apices dark; ascospore walls smooth...*T. rigniacensis*
4.Ascoma apices reddened; ascospore walls finely ornamented...5
5.Ascospore walls foveolate................*T. californica*
5.Ascospore walls delicately longitudinally striate...*T. minima*
6.Ascoma apices yellow to orange.......*T. broussonetiae*
6.Ascoma apices red or vinaceous brown...............7
7.Ascospores 9-12 µm wide, surface coarsely foveolate; ascoma apices reddish brown...................*T. maculans*
7.Ascospores 5-7(-8) µm wide, surface finely foveolate or longitudinally striate......................................8
8.Ascospore surface finely foveolate; ascoma apices red.......................................*T. subrufa*
8.Ascospore surface delicately longitudinally striate...9
9.Ascospores 14.5-20 µm long; ascoma apices vinaceous brown..................................*T. rubronotata*
9.Ascospores 18-25 µm long; ascoma apices red...*T. arizonica*

Thyridaria arizonica M.E. Barr, sp. nov. Fig. 1 a-c

Ascomata immersa globosa 400-500 µm lata, apices vel 165-200 µm alta et lata, rubescens. Asci bitunicati fissitunicati peripheri 120-150 x 9-12 µm. Pseudoparaphyses trabeculae. Ascospores 18-25 x 6-7(-8) µm brunneae triseptatae, striae longitudinales interruptae. Holotypus in foliis emortuis *Yuccae elatae* Engelm. "USA. ARIZONA: Santa Cruz Co., Coronado Nat'l Forest, Santa Rita Mts., Madera Canyon, 9 Aug 1980," a M.E. Barr n. 6777 lectus in NY depositus.

Ascomata immersed, gregarious in old leaf tissues, surrounded by abundant vinaceous-brown hyphae, globose, 400-500 µm diam, papillate apex to surface, ca. 165-200 µm wide and high, terete or slightly compressed at times then broadly ellipsoid in top view, ostiole periphysate, bright red; peridium vinaceous brown, several rows of compressed cells. Hamathecium of trabeculae in gel matrix. Asci bitunicate, fissitunicate, peripheral, cylindric, 120-150 x 9-12 µm. Ascospores 18-25 x 6-7(-8) µm, rich brown, oblong, 3-septate, slightly constricted at median septum, wall longitudinally striate, striae often interrupted, beneath narrow gel coating when young; one globule per cell; uniseriate in the ascus.

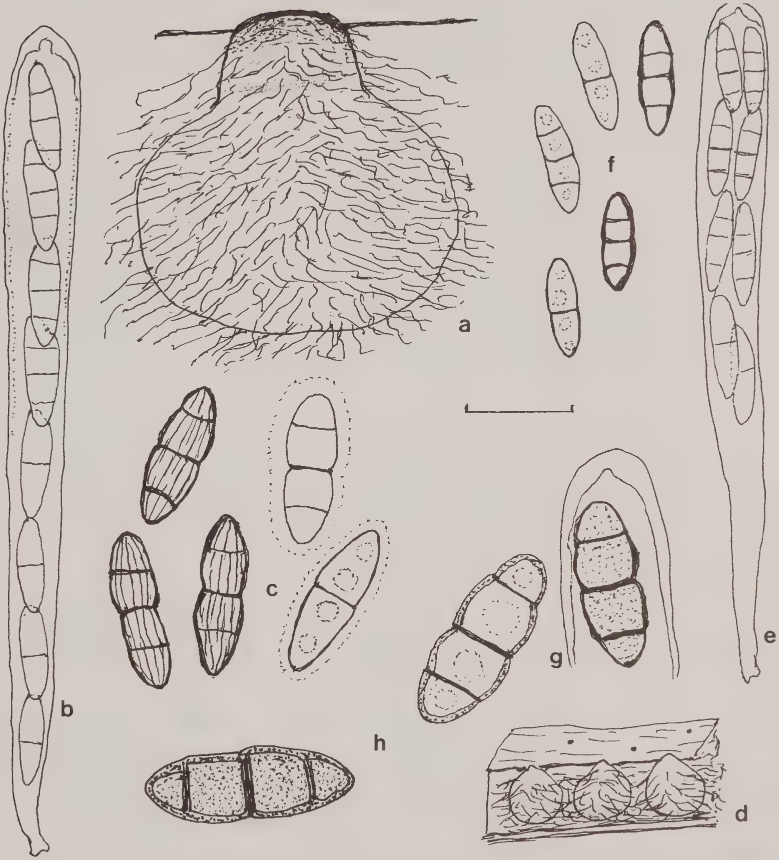

Figure 1. Species of *Thyridaria*. a–c. *T. arizonica*: a. ascoma in outline, b. ascus, c. ascospores. d–f. *T. aurantiolutea*: d. habit of ascomata beneath periderm, e. ascus, f. ascospores. g,h. *T. maculans*: g. ascus apex and uppermost ascospore, h. two ascospores. Standard line = 15 µm for asci and ascospores; 150 µm for a; d not to scale.

Additional collection: USA. Arizona: Huachuca Co., Ramsey Canyon, 17 Apr 1984, in dead leaves of *Yucca schotii* Engelm., S. Fultz (NY).

Thyridaria arizonica introduces a different substrate, dead leaves of *Yucca* L. (Agavaceae), quite apart from the usual woody stems that most species of the genus inhabit. This fungus is suggestive of *Lophiostoma viridarium* Cooke by the ascospore ornamentation and somewhat compressed apical papilla. It differs mostly from *L. viridarium* in smaller ascospores; no greenish tinges were observed on the leaves, a feature that is sometimes but not invariably found in *L. viridarium*.

Thyridaria aurantiolutea M.E. Barr & Vivant, sp. nov. Fig. 1 d-f

Ascomata immersa vel superficialis globosa vel ovoidea 400-450 µm diametro 500-550 µm alta gregaria in hyphae aurantiolutea, apices papillata, peridium vinaceo-aurantia vel brunnescens. Asci bitunicati fissitunicati peripheri 70-85 x 10-12 µm oblongi et stipitati 20-25 µm longi. Ascospores 12-15(-16) x 4.5-5 µm brunneae triseptatae. Holotypus in caulibus *Buxi sempervirenti* L., "FRANCE: Vallee d'Aure, Fabian (65), 19 Sep 1999," a J. Vivant lectus et a F. Candoussau sub n. 6162-672 communicatus in CUP 67181 depositus et isotypus in DAOM depositus.

Ascomata globose to ovoid, 400-450 µm diam, 500-550 µm high, immersed beneath periderm becoming superficial, gregarious in eutypelloid configuration in orange to yellowish hyphae; apex terete, papillate, ostiole periphysate; peridium bright reddish orange over brown rows of cells, compressed in side view. Hamathecium of trabeculae. Asci bitunicate, fissitunicate, peripheral, 70-85 x 10-12 µm, oblong stipitate, stipe 20-25 µm long. Ascospores 12-15(-16) x 4.5-5 µm, brown, ellipsoid, 3-septate, septa and walls dark brown, walls smooth; one globule per cell; partially biseriate to uniseriate in the ascus. Known only from the type collection in *Buxus sempervirens*.

This species belongs among the small-spored taxa in the genus and differs from *T. sambucina* (Peck) Wehm. particularly in more eutypelloid configuration and more brilliant pigmentation of the ascomata. From *T. broussonetiae* it is well separated by ascospore size range.

Thyridaria maculans (Fabre) M.E. Barr, comb.nov. Fig. 1, g-h

Basionym: *Lophiostoma maculans* Fabre, Ann. Sci. Nat. Bot. 6 Ser., 15: 59. 1883.

I have not seen original material and made the identification from the impressive ascospores described and illustrated by Fabre (1883). The taxon is most striking in the heavily pigmented, thickened and strongly foveolate wall of wide ascospores, measuring 20-30 x 9-12 µm. Although

Fabre (1883) described his fungus under *Lophiostoma*, these ascospores are not characteristic for members of that genus. They do fit well among the species of *Thyridaria*. The ascospores in this species may be slightly or strongly versisporous, with both terminal cells paler than mid cells. Fabre described the species from old wood of *Buxus sempervirens* L. Other French collections are in wood of *Salix* L. (near Cepoy, 21 Feb 1997, L. Gauthier), and in wood of *Hedera helix* L. (Forêt de Montargis - Loiret (45), 27 Mar 1999, L. Gauthier 990402-1). Still another European collection was found in wood of *Ulmus* L. in Switzerland (Mont de Corriere, V.D., 15 May 1989, F. Rappaz). Parts of these recent collections are deposited in DAOM.

The species *T. broussonetiae, T. californica* Rehm, *T. minima, T. rubronotata* (Berk. & Broome) Sacc., and *T. sambucina* are all known from North American collections. Wehmeyer (1941) and Barr (1990) described these species. *Thyridaria rigniacensis* Sacc. & Flageolet was reported on *Pseudosasa* sp. from southern France (Candoussau et al. 1996). *Thyridaria subrufa* (Ellis & Everh.) Wehm. was redescribed (Wehmeyer 1941) from the type collection on *Rhus* L. in California. I have found several collections in British Columbia that conform to this species, on *Cytisus scoparius* (L.) Link, *Holodiscus discolor* (Pursh) Maxim, *Oemleria cerasiformis* Hook. & Arnott, *Quercus garryana* Douglas, and *Rosa* sp.

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LITERATURE CITED

Barr, M.E. 1979. A classification of Loculoascomycetes. Mycologia 71: 935-957.

Barr, M.E. 1987. Prodromus to class Loculoascomycetes. Publ. by the author. Amherst, Massachusetts. 168 p.

Barr, M.E. 1990. Melanommatales (Loculoasocmycetes). N. Amer. F. Ser. II, 13: 1-129.

Barr, M.E. 2000. Notes on coprophilous bitunicate ascomycetes. Mycotaxon 76: 105-112.

Candoussau, F., J.-P. Magni, L.E. Petrini, M.E. Barr and O. Petrini. 1996. Bambusicolous fungi collected in Southwestern France: An annotated list. Mycol. Helvetica 8(2): 11-20.

Cannon, P.F., D.L. Hawksworth and M. Sherwood-Pike. 1985. The British Ascomycotina An annotated Checklist. Commonwealth Agric. Bureaux, UK. 302 p.

Dennis, R.W.G. 1978. British Ascomycetes. J. Cramer, Vaduz. 585 p.

Eriksson, O.E. 1992. The non-lichenized pyrenomycetes of Sweden. SBT-förlaget, Lund, Sweden. 208 p.

Eriksson, O.E. 1999. Outline of Ascomycota. Myconet 3: 1-88.

Fabre, J.H. 1883. Essai sur les Sphaeriacees du Departement de Vaucluse (Deuxieme partie). Ann. Sci. Nat. Bot., Sér. 6, 15: 31-69.

Fallah, P.M. and C.A. Shearer. 2001. Freshwater ascomycetes: new or noteworthy species from north temperate lakes in Wisconsin. Mycologia 93: 566-602.

Holm, L. and K. Holm. 1988. Studies in the Lophiostomataceae with emphasis on the Swedish species. Symb. Bot. Upsal. 28(2): 1-50.

Ju, Y.-M., J.D. Rogers and S.M. Huhndorf. 1996. *Valsaria* and notes on *Endoxylina, Pseudothyridaria, Pseudovalsaria*, and *Roussoella*. Mycotaxon 58: 419-481.

Kirk, P.M., P.F. Cannon, J.C. David and J.A. Stalpers. 2001. Ainsworth & Bisby's Dictionary of the Fungi, 9th ed. CAB International, Egham, UK. 955 p.

Luttrell, E.S. 1973. Loculoascomycetes. Ch. 7, pp. 135-219. In: G.C. Ainsworth, F.K. Sparrow and A.S. Sussman (eds.), The Fungi. Vol. IVA. Academic Press, New York.

Müller, E. and J.A. von Arx. 1973. Pyrenomycetes: Meliolales, Coronophorales, Sphaeriales. Ch. 6, pp. 87-132. In: G.C. Ainsworth, F.K. Sparrow and A.S. Sussman (eds.), The Fungi. Vol. IVA. Academic Press, New York.

Munk, A. 1957. Danish Pyrenomycetes. Dansk Bot. Ark. 17(1): 1-491.

Untereiner, W. 1993. A taxonomic revision of the genus *Endoxyla*. Mycologia 85: 294-310.

Wehmeyer, L.E. 1941. The genus *Thyridaria* (Pyrenomycetes). Lloydia 4: 241-261.

Wehmeyer, L.E. 1975. The pyrenomycetous fungi. Mycol. Mem. 6: 1-250. J. Cramer, Lehre, Germany.

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PRELIMINARY CHECKLIST OF AGARICALES FROM CROATIA V: FAMILIES CREPIDOTACEAE, RUSSULACEAE AND STROPHARIACEAE

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ABSTRACT

The fifth and the last part of the preliminary checklist of Agaricales from Croatia is given. It comprises the families Crepidotaceae, Russulaceae and Strophariaceae. 160 species (three of them in a broad sense) belonging to 11 genera are presented. Eight species are reported for the first time from Croatia. For each species, the published and unpublished sources of data are given, as well as the collections in which the material is deposited.

Key words: Basidiomycota, biodiversity, mycoflora, bibliography

INTRODUCTION

This is the fifth and the last part of the preliminary checklist of Agaricales from Croatia. The first four parts have been published in Mycotaxon (Tkalčec & Mešić 2002, Mešić & Tkalčec 2002, Tkalčec & Mešić 2003, Mešić & Tkalčec 2003). This part comprises the families Crepidotaceae, Russulaceae and Strophariaceae. The checklist includes data published or collected before 1 January 2000. Information about the geographical and biogeographical position of Croatia, material, methods and presentation are given in Tkalčec & Mešić (2002).

In this paper we present 160 species (three of them in a broad sense) belonging to 11 genera found on the territory of Croatia, of which we have revised 84 species. Out of the overall number 9 species belong to the family Crepidotaceae, 121 species to the family Russulaceae, and 30 species to the family Strophariaceae. Eight species are reported for the first time from Croatia.

Marks and abbreviations:

* - taxon reported for the first time from Croatia in this paper;
• - at least part of records of taxon revised;
(1) - number in brackets indicates synonym or misapplied name under which the author of the record has quoted the taxon;
( ) - empty brackets indicate that the author of the record has also quoted the taxon under the name we use;
? - (a) question mark instead of an author of combination means that we could not find the author in the literature available to us; (b) question mark following the source of a published record or abbreviation of a collection means that the author himself doubted his original identification;
= **?** - taxon not found in modern taxonomic literature;
Exs. - collections in which the dried material (exsiccatum) is deposited;
HR? - taxon most probably found in the territory of Croatia (locality not precisely quoted);
Incl. - including;
Lit. - literature;
Misappl. - misapplied name;
Ref. - references (sources of records of taxon);
unp. - unpublished data.

SURVEY OF TAXA

Family **Crepidotaceae** (S. Imai) Singer

Crepidotus (Fr.) Staude
= *Pleurotellus* Fayod

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Norstein 1990, Pilát 1948, Senn-Irlet 1992 a, Senn-Irlet 1992 b, Senn-Irlet 1995, Singer 1986, Watling & Gregory 1989)

Crepidotus applanatus (Pers.) P. Kumm.
= *Derminus applanatus* (Pers.) ? (1)
Ref.: Blagaić 1921, Škorić 1928 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1989, unp. Tortić
Exs.: CNF

•***Crepidotus autochthonus*** J.E. Lange
= *Crepidotus fragilis* Joss. (nom. inval.) (1)
= *Crepidotus mollis* (Schaeff. : Fr.) Staude var. *pseudoapplanatus* Pilát (2)
Ref.: Tortić 1968 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)(2)
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Moser 1983, Watling & Gregory 1989)

•***Crepidotus calolepis*** (Fr.) P. Karst.
= *Crepidotus mollis* (Schaeff. : Fr.) Staude var. *calolepis* (Fr.) P. Karst. (1)
Ref.: Focht 1974 (1), unp. Kotlaba (according to unp. Tortić), unp. Tkalčec & Mešić
Exs.: CNF, PRM
(Lit.: Moser 1983, Watling & Gregory 1989)

•***Crepidotus cesatii*** (Rabenh.) Sacc.
= *Crepidotus sphaerosporus* (Pat.) J.E. Lange
Ref.: Focht 1974, Tortić 1968 b, Tortić 1973, unp. Tortić
Exs.: CNF

var. ***cesatii***
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Senn-Irlet 1995)

•***Crepidotus epibryus*** (Fr. : Fr.) Quél.
= *Pleurotellus graminicola* Fayod
= *Crepidotus herbarum* (Peck) Sacc.
= *Pleurotellus herbarum* (Peck) Singer
= *Crepidotus hypnophilus* (Pers.) Norstein
= *Pleurotellus hypnophilus* (Pers.) Fayod
= *Agaricus pubescens* Sowerby (nom. illeg.) (1)
Ref.: Škorić 1928 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Senn-Irlet 1995, Watling & Gregory 1989)

•***Crepidotus luteolus*** (Lambotte) Sacc.
Ref.: Tortić 1973, unp. Tkalčec & Mešić
Exs.: CNF, PRM
(Lit.: Senn-Irlet 1995)

•***Crepidotus mollis*** (Schaeff. : Fr.) Staude
= *Agaricus mollis* Schaeff. : Fr. (1)
Ref.: Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1973, Tortić 1989, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić, Pilát 1948 HR?
Exs.: CNF, PRM
(Lit.: Moser 1983, Watling & Gregory 1989)

Crepidotus variabilis (Pers. : Fr.) P. Kumm.
= *Agaricus variabilis* Pers. : Fr. (1)
Ref.: Barčić 1982, Barčić 1996, Schulzer 1882 (1), Schulzer *& al.* 1866 (1), Vrščaj 1990
Exs.: CNF

Tubaria (W.G. Sm.) Gillet

(Lit: Arnolds *& al.* 1995, Bon 1992, Dennis *& al.* 1960, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986)

Tubaria furfuracea (Pers. : Fr.) Gillet **sensu lato**
Incl..: *Tubaria furfuracea* (Pers. : Fr.) Gillet (1)
Tubaria hiemalis Romagn. ex Bon
Tubaria romagnesiana Arnolds
Ref.: Focht 1972 (1), Focht 1974 (1), Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF
Annotation: This is an aggregate of a few very similar species (by some authors possibly forms of one species) which are often misidentified. Therefore, without revision it is not possible to know which species the authors of the quotes for Croatia have found.

Family **Russulaceae** Roze ex Lotsy

Lactarius Pers. ("*Lactaria*")

(Lit.: Arnolds *& al.* 1995, Basso 1999, Bon 1980, Dennis *& al.* 1960, Hansen & Knudsen 1992, Heilmann-Clausen *& al.* 1998, Kreisel 1987, Moser 1983, Neuhoff 1956, Noordeloos & Kuyper 1999, Pilát 1951, Rauschert 1989, Singer 1986)

Lactarius acerrimus Britzelm.
Ref.: Focht 1974, Stropnik *& al.* 1988, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Tortić
Exs.: CNF

•***Lactarius acris*** (Bolton : Fr.) Gray
= *Agaricus acris* Bolton : Fr. (1)
Ref.: Blagaić 1921, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Heilmann-Clausen *& al.* 1998)

•***Lactarius albocarneus*** Britzelm.
= *Lactarius glutinopallens* F.H. Møller et J.E. Lange (1)
Ref.: Lisiewska 1993 (1), Lisiewska & Tortić 1990 (1), Tortić 1973 (1), unp. Tkalčec & Mešić, unp. Tortić (1)

Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius aurantiacus*** (Pers. : Fr.) Gray
= *Lactarius mitissimus* (Fr. : Fr.) Fr. (1)
Ref.: Barčić 1996 (1), Tortić 1966 a (1), Tortić 1966 b (1), Vouk & Pevalek 1916 (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Heilmann-Clausen *& al.* 1998)

•***Lactarius azonites*** (Bull.) Fr.
Ref.: Focht 1974, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius blennius*** (Fr. : Fr.) Fr.
= *Lactarius blennius* (Fr. : Fr.) Fr. f. *virescens* J.E. Lange (1)
Ref.: Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1994, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Heilmann-Clausen *& al.* 1998)

•***Lactarius camphoratus*** (Bull.) Fr.
Ref.: Barčić 1982, Barčić 1996, Focht 1986, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1973, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius chrysorrheus*** Fr.
Ref.: Barčić 1982, Barčić 1996, Focht 1974, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius circellatus*** Fr.
Ref.: Tortić 1968 b, Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius controversus*** Pers. : Fr.
Ref.: Tortić 1968 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius decipiens*** Quél.
Ref.: Focht 1986, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius deliciosus*** (L. : Fr.) Gray
= *Lactarius deliciosus* (L. : Fr.) Gray var. *pini* Vassilkov (1)
Ref.: Barčić 1982, Barčić 1996, Blagaić 1931, Focht 1972, Focht 1979, Forenbacher 1915, Gjurašin 1898, Kranjčev 1995, Lorinser - Janda 1877, Schulzer *& al.* 1866, Škorić 1928, Vouk & Pevalek 1915, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius deterrimus*** Gröger
Ref.: Kranjčev 1995, Lisiewska 1993, Lisiewska & Tortić 1990, Tortić 1993, Tortić 1994, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius evosmus*** Kühner et Romagn.
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius fascinans (Fr. : Fr.) Fr.
Ref.: Vouk & Pevalek 1916

•***Lactarius flavidus*** Boud.
= *Lactarius aspideus* (Fr. : Fr.) Fr. var. *flavidus* (Boud.) Neuhoff (1)
Ref.: Tortić 1968 b, unp. Tkalčec & Mešić, unp. Tortić ( )(1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius fuliginosus (Fr. : Fr.) Fr.
Ref.: Lisiewska & Tortić 1990, Tortić 1973, unp. Tortić
Exs.: CNF, POZM

•***Lactarius glaucescens*** (Crossl.) A. Pearson
- as *Lactarius pargamenus* (Sw. : Fr.) Fr. (1)
Ref.: Focht 1979, Focht 1986 (rev.) (1), Tortić & Lisiewska 1978, unp. Lisiewska, unp. Matočec (rev.) (1), unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius glyciosmus*** (Fr. : Fr.) Fr.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1968 b, Tortić 1994, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF
(Lit.: Heilmann-Clausen *& al.* 1998)

Lactarius hepaticus Plowr.
Ref.: Focht 1974

Lactarius hysginus (Fr. : Fr.) Fr.
Ref.: Barčić 1996

•***Lactarius lignyotus*** Fr.
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius mairei*** Malençon
= *Lactarius mairei* Malençon var. *zonatus* A. Pearson (1)
Ref.: Focht 1974 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius pallidus*** Pers. : Fr.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius picinus*** Fr.
Ref.: Tortić 1966 a, Tortić 1966 b, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius piperatus*** (L. : Fr.) Pers.
= *Agaricus piperatus* L. : Fr. (1)
Ref.: Blagaić 1921, Blagaić 1931, Božac 1982, Božac 1986, Božac 1989, Božac 1993, Focht 1972, Focht 1974, Lisiewska & Tortić 1990, Lorinser - Janda 1877, Mužic & Božac 1997, Schulzer *& al.* 1866, Škorić 1928, Tortić 1964, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius piperatus (L. : Fr.) Pers. **sensu lato**
Incl.: *Lactarius glaucescens* (Crossl.) A. Pearson (1)
Lactarius piperatus (L. : Fr.) Pers. (2)
Ref.: Tortić 1966 a (2=1), Tortić 1973 (2=1), Tortić 1993

•***Lactarius pterosporus*** Romagn.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius pubescens*** (Schrad. →) Fr.
= *Lactarius blumii* Bon
- as *Lactarius cilicioides* (Fr. : Fr.) Fr. (rev.) (1)
Ref.: Božac 1982 (1), Božac 1984 (1), Božac 1986 (1), Božac 1989 (1), Božac 1993 (1),Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1968 b, Tortić 1994, unp. Tkalčec & Mešić, unp. Tortić, Focht 1979 HR?
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius pyrogalus*** (Bull. : Fr.) Fr.
= *Lactarius hortensis* Velen.
Ref.: Schulzer *& al.* 1866, Tortić 1966 a, Tortić 1966 b, Vouk & Pevalek 1916, unp. Tkalčec & Mešić, unp. Tortić, Blagaić 1921 ?
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius quieticolor*** Romagn.

*•var. ***quieticolor***
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Basso 1999)

var. ***hemicyaneus*** (Romagn.) Basso
= *Lactarius hemicyaneus* Romagn. (1)
Ref.: Focht 1986 (1)

•***Lactarius quietus*** (Fr. : Fr.) Fr.
Ref.: Škorić 1928, Tortić 1968 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

*•***Lactarius rufus*** (Scop. : Fr.) Fr.
Ref.: unp. Matočec, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius salmonicolor*** R. Heim et Leclair
= *Lactarius salmoneus* R. Heim et Leclair (nom. illeg.) non *L. salmoneus* Peck (1)
= *Lactarius subsalmoneus* Pouzar (2)
Ref.: Focht 1979 (1), Lisiewska 1993, Lisiewska & Tortić 1990, Poštenjak 1983 (1), Tortić 1964 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 a (2), Tortić 1993, Tortić 1994, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(2)

Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius sanguifluus*** (Paulet) Fr.
Ref.: Božac 1982, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1972, Focht 1974, Focht 1979, Focht 1981, Focht 1986, Mužic & Božac 1984, Mužic & Božac 1997, Vrščaj 1990, unp. Matočec, unp. Tkalčec & Mešić, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999)

•***Lactarius scrobiculatus*** (Scop. : Fr.) Fr.
Ref.: Blagaić 1921, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius semisanguifluus*** R. Heim et Leclair
Ref.: Focht 1979, Poštenjak 1983, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Focht 1986 HR?
Exs.: CNF, POZM
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius serifluus (DC. : Fr.) Fr.
Ref.: Gjurašin 1898, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

•***Lactarius subdulcis*** (Bull. : Fr.) Gray
= *Agaricus subdulcis* Bull. : Fr. (1)
Misappl.: *Lactarius serifluus* (DC. : Fr.) Fr. sensu J. Schröt. non DC. (2)
Ref.: Schulzer *& al.* 1866, Škorić 1928, Tortić 1966 a, Tortić 1973, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916 (2), unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius torminosus*** (Schaeff. : Fr.) Pers.
= *Agaricus torminosus* Schaeff. : Fr. (1)
Ref.: Gjurašin 1898, Lorinser - Janda 1877, Schulzer *& al.* 1866, Škorić 1928, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1994, Vouk & Pevalek 1915, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Focht 1979 HR?, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius turpis*** (Weinm.) Fr.
Misappl.: *Lactarius necator* (Bull. : Fr.) Pers. sensu auct. non Bull. (1)

Misappl.: *Lactarius plumbeus* (Bull. : Fr.) Gray sensu auct. non Bull. (2)
Ref.: Lange 1974 (1), Škorić 1928 (2), unp. Matočec (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius uvidus (Fr. : Fr.) Fr.
Ref.: Focht 1972, Focht 1974, Gjurašin 1898, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

•***Lactarius vellereus*** (Fr. : Fr.) Fr.
= *Lactarius albivellus* Romagn.
Ref.: Barčić 1982, Barčić 1996, Božac 1982, Božac 1984, Božac 1986, Božac 1989, Božac 1993, Focht 1972, Focht 1974, Gjurašin 1898, Lisiewska & Tortić 1990, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius violascens (J. Otto : Fr.) Fr.
Ref.: Škorić 1928

•***Lactarius volemus*** (Fr. : Fr.) Fr.
= *Agaricus volemus* Fr. : Fr. (1)
= *Lactarius lactifluus* (Schaeff.) Quél. (2)
Ref.: Blagaić 1921, Blagaić 1931, Focht 1972, Focht 1974, Focht 1979, Gjurašin 1898 (2), Kranjčev 1979, Kranjčev 1986, Lisiewska & Tortić 1990, Schulzer *& al.* 1866, Škorić 1928, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

•***Lactarius zonarius*** (Bull.) Fr.
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Basso 1999, Heilmann-Clausen *& al.* 1998)

Lactarius zonarius (Bull.) Fr. **sensu lato**
Incl.: *Lactarius acerrimus* Britzelm.
  Lactarius evosmus Kühner et Romagn. (1)
  Lactarius insulsus (Fr. : Fr.) Fr. - nom. dub. (Heilmann-Clausen & *al.* 1998) (2)
    = *Agaricus insulsus* Fr. : Fr. (3)
  Lactarius zonarioides Kühner et Romagn.
  Lactarius zonarius (Bull.) Fr. (4)

= *Lactarius zonarius* (Bull.) Fr. var. *scrobipes* (Kühner et Romagn.) Bon (5)

Ref.: Focht 1972 (2), Focht 1974 (1)(2)(5), Focht 1979 (2)(4), Gjurašin 1898 (4), Schulzer 1879 b (4), Tortić 1968 b (2), Tortić & Lisiewska 1978 (2), unp. Lisiewska (2), unp. Matočec (4), unp. Tortić (2)(4), Schulzer 1857 HR? (3)

Exs.: CNF (2), POZM (2)

Annotation: Species in this group have been often interpreted in a few different senses (see Basso 1999, Heilmann-Clausen *& al.* 1998). We do not know which senses have been used by the authors of the quotes without revision.

Russula Pers.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Bon 1988, Dennis *& al.* 1960, Einhellinger 1994, Galli 1996, Hansen & Knudsen 1992, Kreisel 1987, Kuyper & Vuure 1995, Moser 1983, Rauschert 1989, Romagnesi 1967, Romagnesi 1985, Sarnari 1998, Singer 1986, Vuure 1992)

•***Russula acrifolia*** Romagn.

Misappl.: *Russula densifolia* (Secr.) ex Gillet sensu Jul. Schäff., auct. p. p. non Gillet (1)

Ref.: Focht 1986, Tortić 1966 a (1), Tortić 1966 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)

Exs.: CNF

(Lit.: Romagnesi 1985, Sarnari 1998)

****Russula adulterina*** Fr.

Ref.: unp. Tortić

Exs.: CNF

Russula adusta (Pers. : Fr.) Fr.

Ref.: Škorić 1928, Tortić 1973, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić

Exs.: POZM

Russula aeruginea Lindblad ex Fr.

Ref.: Focht 1986, Škorić 1928, Vouk & Pevalek 1916

Russula albonigra (Krombh.) Fr.

Ref.: Focht 1974, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tortić

Exs.: CNF

Russula alutacea (Pers. : Fr.) Fr.

Ref.: Focht 1974, Focht 1986, Lorinser - Janda 1877, Schulzer *& al.* 1866, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić, Schulzer 1857 HR?

Exs.: POZM

Russula amarissima Romagn. et J.-E. Gilbert
Ref.: Focht 1974

Russula amethystina Quél.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tortić
Exs.: CNF

Russula amoena Quél. **sensu lato**
Incl.: *Russula amoena* Quél.
Russula amoenicolor Romagn.
Russula violeipes Quél.
Misappl.: *Russula mariae* Peck sensu Jul. Schäff. non Peck (1)
Ref.: Focht 1974 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF (1)

*•***Russula amoenicolor*** Romagn.
Ref.: unp. Tkalčec & Mešić, Focht 1986 HR?
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula aquosa Leclair
Ref.: Focht 1986

Russula aurantiaca (Jul. Schäff.) Jul. Schäff.
Ref.: Focht 1974, Focht 1986

•***Russula aurea*** Pers.
= *Russula aurata* (With.) Fr. (1)
= *Russula aureocitrina* (Krombh.) ? (2)
= *Russula esculenta* Pers. (3)
Ref.: Focht 1979 (1), Focht 1986 (1), Lorinser - Janda 1877 (1), Schulzer *& al.* 1866 ( )(2)(3), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 b (1), Tortić & Lisiewska 1978 (1), unp. Tkalčec & Mešić, unp. Tortić (1), Schulzer 1857 HR? ( )(3)
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula aurora Krombh.
= *Russula rosea* (Schaeff. →) Quél. (nom. illeg.) (1)
= *Russula velutipes* Velen.
Ref.: Focht 1986 (1), Tortić 1968 b (1), Tortić & Lisiewska 1978 (1), unp. Tortić (1)
Exs.: CNF

Russula badia Quél.
Ref.: Focht 1974, Tortić 1966 a, Tortić 1966 b, unp. Tortić, Focht 1986 HR?
Exs.: CNF

Russula brunneoviolacea Crawshay
Ref.: Focht 1986

•***Russula chloroides*** (Krombh.) Bres.
= *Russula delica* Fr. var. *glaucophylla* Quél. (1)
= *Russula delicula* Romagn. (2)
Ref.: Focht 1974, Focht 1986 ( )(1)(2), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Romagnesi 1985)

Russula coerulea (Pers. →) Fr.
Ref.: Focht 1986, Schulzer *& al.* 1866, Schulzer 1857 HR?

Russula consobrina (Fr. : Fr.) Fr.
Ref.: Focht 1986, unp. Matočec

Russula curtipes F.H. Møller et Jul. Schäff.
Ref.: Focht 1974

•***Russula cyanoxantha*** (Schaeff.) Fr.
Ref.: Barčić 1982, Barčić 1996, Blagaić 1921, Focht 1979, Focht 1986, Gjurašin 1898, Kranjčev 1979, Lisiewska & Tortić 1990, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Romagnesi 1985)

•***Russula delica*** Fr.
= *Russula deliciosa* (Vaill.) ex J. Schröt. (nom. illeg.) (1)
Misappl.: *Russula delica* Fr. var. *elephantina* (Fr.) Melzer et Zvára sensu Melzer et Zvára non Fr. (2)
Ref.: Focht 1974, Focht 1986, Jelić & Tortić 1973, Lisiewska & Tortić 1990, Schulzer 1882, Škorić 1928 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1915 (1), Vouk & Pevalek 1916 (1), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Focht 1986 HR? (2)
Exs.: CNF
(Lit.: Romagnesi 1985)

•***Russula densifolia*** (Secr.) ex Gillet
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Romagnesi 1985)

•***Russula emetica*** (Schaeff. : Fr.) Pers.
Ref.: Barčić 1989, Barčić 1996, Blagaić 1921, Blagaić 1931, Gjurašin 1898, Lisiewska & Tortić 1990, Škorić 1928, Tortić 1966 a, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Romagnesi 1985)

var. ***silvestris*** Singer
= *Russula silvestris* (Singer) Reumaux
Ref.: Focht 1986

Russula fellea (Fr. : Fr.) Fr.
Ref.: Focht 1974, Focht 1986, Tortić 1973, Tortić & Lisiewska 1978, unp. Tortić
Exs.: CNF

Russula flavispora (J. Blum) ex Romagn.
Ref.: Focht 1986

•***Russula foetens*** Pers. : Fr.
Ref.: Blagaić 1931, Focht 1974, Focht 1986, Schulzer 1882, Schulzer *& al.* 1866, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1993, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR?
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula fragilis (Pers. : Fr.) Fr.
= *Russula emetica* (Schaeff. : Fr.) Pers. var. *fragilis* (Pers. : Fr.) Quél. (1)
= *Russula nivea* (Pers.) ? (2)
Ref.: Focht 1979, Gjurašin 1898 (1), Lorinser - Janda 1877, Schulzer 1882, Schulzer *& al.* 1866 ( )(2), Škorić 1928, Vouk & Pevalek 1916, unp. Tortić
Exs.: CNF

Russula gilva Zvára
Ref.: Focht 1986

•***Russula grata*** Britzelm.
= *Russula laurocerasi* Melzer (1)
= *Russula laurocerasi* Melzer var. *fragrans* (Romagn.) Kuyper et Vuure (= var. *grata*)
Ref.: Lisiewska & Tortić 1990 (1), Tortić 1993 (1)

•var. ***laurocerasi*** (Melzer) Rauschert
= *Russula laurocerasi* Melzer var. *laurocerasi*
Ref.: Tortić 1966 a (1), Tortić 1968 b (1), Tortić & Lisiewska 1978 (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula grisea (Pers. →) Fr.
= *Russula palumbina* Quél. (1)
= *Russula suavis* Schulzer (2)
Ref.: Blagaić 1931, Focht 1974, Schulzer 1881 (2), Schulzer 1885 (1) Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tortić
Exs.: CNF

•***Russula heterophylla*** (Fr.) Fr.
Ref.: Tortić 1966 a, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR?
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula ilicis Romagn., Chevassut et Privat
Ref.: Focht 1986

Russula insignis Quél.
Misappl.: *Russula livescens* (Batsch) Quél. sensu Bres. non Batsch (1)
Ref.: Focht 1986 (1)

Russula integra (L.) Fr.
Ref.: Focht 1974, Focht 1986, Lorinser - Janda 1877, Schulzer 1882, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Vouk & Pevalek 1916, unp. Tortić, Schulzer *& al.* 1866 ?
Exs.: CNF

Russula laeta F.H. Møller et Jul. Schäff.
Ref.: Focht 1974, Focht 1979, Focht 1986 HR?

Russula lateritia Quél.
Ref.: Focht 1986

Russula lilacea Quél.
= *Russula lilacea* Quél. var. *carnicolor* Bres. (1)
Ref.: Focht 1986 (1), Gjurašin 1898, Tortić 1968 b, unp. Tortić
Exs.: CNF

•***Russula luteotacta*** Rea
Ref.: Focht 1986, Tortić 1966 a, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula maculata Quél.
Ref.: Focht 1974, Focht 1986

Russula mairei Singer
Ref.: Focht 1974, Lisiewska 1993, Lisiewska & Tortić 1990, Tortić 1973, Tortić & Lisiewska 1978, unp. Lisiewska, unp. Tortić
Exs.: CNF, POZM

*•***Russula medullata*** Romagn.
Ref.: unp. Tkalčec & Mešić, Focht 1986 HR?
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula melliolens Quél.
Ref.: Tortić 1968 b, unp. Tortić, Focht 1986 HR?
Exs.: CNF

Russula mustelina Fr.
Ref.: Tortić 1966 a

•***Russula nigricans*** (Bull. →) Fr.
= *Russula nigrescens* (Krombh.) Schulzer (1)
Ref.: Focht 1974, Focht 1986, Kranjčev 1991, Kranjčev 1995, Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Romagnesi 1985)

•***Russula nitida*** (Pers. : Fr.) Fr.
Ref.: Focht 1986, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula ochroleuca Pers.
Ref.: Lisiewska & Tortić 1990, Schulzer *& al.* 1866, Tortić 1973, Vouk & Pevalek 1916, unp. Tortić, Schulzer 1857 HR?
Exs.: CNF

Russula olivacea (Schaeff.) Pers.
Ref.: Focht 1974, Focht 1979, Focht 1986, Škorić 1928, Tortić 1968 b, Vouk & Pevalek 1916, unp. Lisiewska
Exs.: CNF, POZM

Russula paludosa Britzelm.
Ref.: Tortić & Lisiewska 1978

Russula pectinata Fr.
Ref.: Focht 1974, Focht 1986, Škorić 1928, Vouk & Pevalek 1916

*•***Russula pectinatoides*** Peck
Misappl.: *Russula pectinata* Fr. sensu Jul. Schäff., auct. p. p. non Fr. (1)
Ref.: unp. Tkalčec & Mešić, unp. Tortić (1), Focht 1986 HR?
Exs.: CNF
(Lit.: Romagnesi 1985, Sarnari 1998)

Russula persicina Krombh.
Misappl.: *Russula rubicunda* Quél. sensu Jul. Schäff., auct. p. p. non Quél. (1)
Ref.: Focht 1974 (1), Focht 1979 (1), Focht 1986 (1)

Russula postiana Romell
Misappl.: *Russula olivascens* Pers. sensu Bres. (1)
Ref.: Focht 1986 (1)

Russula pseudodelica J.E. Lange **sensu lato**
Incl.: *Russula pallidospora* (J. Blum) ex Romagn.
Misappl.: *Russula pseudodelica* J.E. Lange sensu Jul. Schäff. non J.E. Lange

Russula pseudodelica J.E. Lange (1)
Ref.: Focht 1974 (1), Focht 1986 HR? (1)
Annotation: Author of the records for Croatia does not make distinction between these two species.

Russula puellaris Fr.
= *Russula puellaris* Fr. var. *leprosa* Bres (1)
Ref.: Focht 1974, Saccardo 1887 HR? (1)

Russula queletii Fr.
Ref.: Lisiewska 1993, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1994, unp. Tortić
Exs.: CNF

Russula risigallina (Batsch) Sacc.
= *Russula chamaeleontina* Fr. (1)
= *Russulina chamaeleontina* (Fr.) ? (2)
= *Russula lutea* (Huds. : Fr.) Gray var. *armeniaca* (Cooke) ? (3)
Ref.: Focht 1974 (1), Tortić & Lisiewska 1978 (1), Vouk & Pevalek 1916 (2), Focht 1986 HR? (3)
Exs.: CNF

Russula risigallina (Batsch) Sacc. **sensu lato**
Incl.: *Russula acetolens* Rauschert
Russula risigallina (Batsch) Sacc.
= *Russula lutea* (Huds. : Fr.) Gray (nom. dub., nom. ambig. - Rauschert 1989) (1)
Ref.: Gjurašin 1898 (1), Lisiewska & Tortić 1990 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF

Russula romellii Maire
Ref.: Focht 1979, Focht 1986

•***Russula rosea*** Pers.
= *Russula lepida* Fr. (1)
= *Russula rosacea* (Pers.) Gray (nom. illeg.) (2)
Misappl.: *Russula lepida* Fr. f. *lactea* (Pers.) F.H. Møller et Jul. Schäff. sensu F.H. Møller et Jul. Schäff. non Pers. (3)
Ref.: Blagaić 1921 b (1), Focht 1986 (1), Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1968 b (1), Tortić & Lisiewska 1978 (1)(3), Vouk & Pevalek 1916 (2), unp. Lisiewska (2), unp. Tkalčec & Mešić, unp. Tortić (1)(3), Focht 1979 HR? (1)
Exs.: BEO (1), CNF, POZM (2)
(Lit.: Romagnesi 1985)

Russula rubra (Lam. ex Fr. : Fr.) Fr.
Ref.: Gjurašin 1898, Lorinser - Janda 1877, Schulzer *& al.* 1866, Vouk & Pevalek 1916

Russula rubroalba (Singer) Romagn.
Ref.: Focht 1986

Russula sanguinaria (Bull. → Schumach.) Rauschert
= *Russula sanguinea* (Bull. →) Fr. (1)
Ref.: Blagaić 1921 (1), Focht 1972 (1), Focht 1974 (1), Mužic & Božac 1984 (1), Vouk & Pevalek 1915 (1)

Russula sardonia Fr.
= *Russula sardonia* Fr. var. *mellina* Melzer (1)
= *Russula drimeia* Cooke
Ref.: Focht 1986 (1), Škorić 1928

Russula seperina Dupain
Ref.: Focht 1986

Russula solaris Ferd. et Winge
Ref.: Focht 1986, Lisiewska 1993, Lisiewska & Tortić 1990, unp. Tortić
Exs.: CNF

•***Russula sororia*** (Fr.) Romell
Ref.: Focht 1974, Focht 1986, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula torulosa Bres.
Ref.: Božac 1989, Božac 1993, Focht 1974, Focht 1986

Russula undulata Velen.
= *Russula atropurpurea* (Krombh.) Britzelm. (comb. illeg.) non *R. atropurpurea* Peck (1)
= *Russula krombholzii* Shaffer
Misappl.: *Russula nauseosa* (Pers.) Fr. sensu Bres. non sensu Fr. (2)
Ref.: Focht 1974 (2), Focht 1986 (2), Tortić 1968 b (1), unp. Tortić (1)
Exs.: CNF

Russula urens Romell
Ref.: Focht 1974

Russula velenovskyi Melzer et Zvára
Ref.: Focht 1986, Lisiewska & Tortić 1990, unp. Tortić

var. ***cruentata*** (Quél. et Schulzer) J. Blum ex Bon
= *Russula cruentata* Quél. et Schulzer (1)
Ref.: Saccardo 1887 (1), Schulzer 1885 (1)

•***Russula vesca*** Fr.
Ref.: Focht 1974, Lisiewska & Tortić 1990, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Romagnesi 1985)

Russula veternosa Fr.
Ref.: Focht 1974, Focht 1986

Russula violacea Quél. **sensu lato**
Incl.: *Russula cavipes* Britzelm. (1)
Misappl.: *Russula violacea* Quél. sensu Jul. Schäff., auct. p. p. non Quél.
Russula violacea Quél. (2)
Ref.: Gjurašin 1898 (2), Tortić 1966 b (2), Tortić 1968 b (2), Tortić & Lisiewska 1978 (2), unp. Tortić (2), Tortić 1966 a ? (1)(2)
Exs.: CNF (1)
Annotation: The authors of the records for Croatia could easily have misapplied name *Russula violacea* to species *R. cavipes*.

•***Russula violeipes*** Quél.
= *Russula amoena* Quél. var. *violeipes* (Quél.) Singer (1)
Ref.: Focht 1972 (1), Focht 1986, unp. Lisiewska, unp. Matočec, unp. Tkalčec & Mešić
Exs.: CNF, POZM
(Lit.: Romagnesi 1985)

•***Russula virescens*** (Schaeff.) Fr.
= *Russula aeruginosa* (Pers.) Krombh. (1)
Ref.: Blagaić 1931, Focht 1981 a, Jelić & Tortić 1973, Kranjčev 1979, Kranjčev 1986 b, Lorinser - Janda 1877, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, Vouk & Pevalek 1916, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić, Focht 1979 HR?, Focht 1986 HR?, Schulzer 1857 HR?
Exs.: BEO, CNF
(Lit.: Romagnesi 1985)

*****Russula viscida*** Kudřna
Ref.: unp. Tortić
Exs.: CNF

Russula xerampelina (Schaeff.) Fr.
= *Russula xerampelina* (Schaeff.) Fr. var. *erythropus* (Pelt.) Konrad et J. Favre (1)
- as *Russula xerampelina* (Schaeff.) Fr. var. *xerampelina* (2)
Ref.: Barčić 1982, Lisiewska & Tortić 1990 (2), Schulzer *& al.* 1866, Tortić 1966 a ( )(1), Tortić & Lisiewska 1978, unp. Tortić ( )(2), Schulzer 1857 HR?

Russula xerampelina (Schaeff.) Fr. **sensu lato**
Ref.: Barčić 1996, Tortić 1993

MOST PROBABLY FOUND IN THE TERRITORY OF CROATIA

Russula amoena Quél.
Ref.: Focht 1986 HR?

Russula anatina Romagn.
Ref.: Focht 1986 HR?

Russula citrinochlora Singer
Ref.: Focht 1986 HR?

Russula galochroa (Fr.) Fr.
Ref.: Focht 1986 HR?

Russula odorata Romagn.
Ref.: Focht 1986 HR?

Russula pseudointegra Arnould et Goris
Ref.: Focht 1986 HR?

Russula straminea Malençon
Ref.: Focht 1986 HR?

Russula vinosobrunnea (Bres.) Romagn.
Ref.: Focht 1986 HR?

Family **Strophariaceae** Singer et A.H. Sm.

Hypholoma (Fr.) P. Kumm.
= *Naematoloma* P. Karst.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Fries 1821, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1987)

•***Hypholoma capnoides*** (Fr. : Fr.) P. Kumm.
= *Naematoloma capnoides* (Fr. : Fr.) P. Karst. (1)
= *Psilocybe capnoides* (Fr. : Fr.) Noordel.
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), Tortić 1989, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(1), Focht 1979 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

Hypholoma ericaeum (Pers. : Fr.) Kühner
= *Psilocybe ericaea* (Pers. : Fr.) Quél. (1)
Ref.: Gjurašin 1898 (1)

•***Hypholoma fasciculare*** (Huds. : Fr.) P. Kumm.
= *Agaricus fascicularis* Huds. : Fr. (1)
= *Naematoloma fasciculare* (Huds. : Fr.) P. Karst. (2)
= *Psilocybe fascicularis* (Huds. : Fr.) Noordel.
Ref.: Barčić 1982, Barčić 1996, Blagaić 1921, Blagaić 1931, Focht 1974 (2), Forenbacher 1915, Jelić & Tortić 1973, Lisiewska & Tortić 1990, Schulzer 1882 (1), Schulzer *& al.* 1866 (1), Škorić 1928, Vouk & Pevalek 1915, Vouk & Pevalek 1916, Tortić 1964 (2), Tortić 1966 a (2), Tortić 1966 b (2), Tortić 1968 a, Tortić 1989, Tortić 1993, Tortić 1994,

Tortić & Lisiewska 1978, Urbani 1946, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić ( )(2), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

•***Hypholoma lateritium*** (Schaeff. : Fr.) J. Schröt.
= *Agaricus lateritius* Schaeff. : Fr. (1)
= *Psilocybe lateritia* (Schaeff. : Fr.) Noordel.
= *Hypholoma sublateritium* (Fr.) Quél. (2)
= *Naematoloma sublateritium* (Fr.) P. Karst. (3)
Ref.: Blagaić 1921 (2), Focht 1979 (3), Focht 1983 (3), Gjurašin 1898 (2), Jelić & Tortić 1973 (2), Schulzer 1882 (1), Schulzer *& al.* 1866 (1), Tortić 1964 (3), Tortić 1966 a (3), Tortić 1966 b (3), Tortić 1989 (2), Tortić & Lisiewska 1978 (2), Vouk & Pevalek 1915, unp. Matočec (2), unp. Tkalčec & Mešić, unp. Tortić (2)(3), Schulzer 1857 HR? (1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983, Watling & Gregory 1987)

•***Hypholoma marginatum*** (Pers.) J. Schröt.
= *Psilocybe marginata* (Pers.) Noordel.
= *Hypholoma dispersum* (Fr. →) Quél. (1)
= *Naematoloma dispersum* (Fr. → Quél.) P. Karst. (2)
Ref.: Tortić 1966 a (2), Tortić 1966 b (2), Tortić 1973 (1), unp. Tkalčec & Mešić, unp. Tortić (1)(2)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983, Watling & Gregory 1987)

Kuehneromyces Singer et A.H. Sm.

(Lit.: Arnolds *& al.* 1995, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Jacobsson 1991, Kreisel 1987, Moser 1983, Singer 1986)

•***Kuehneromyces mutabilis*** (Scop. : Fr.) Singer et A.H. Sm.
= *Agaricus mutabilis* Scop. : Fr. (1)
= *Pholiota mutabilis* (Scop. : Fr.) P. Kumm. (2)
Ref.: Blagaić 1921 (2), Blagaić 1931 (2), Božac 1982 (2), Božac 1984, Božac 1986, Božac 1989 ( )(2), Božac 1993 ( )(2), Focht 1986, Kranjčev 1979 (2), Kranjčev 1986, Škorić 1928 (2), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1968 a, Tortić 1979, Tortić 1989, Tortić 1993, Tortić 1994, Vouk & Pevalek 1916 (2), unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić 1970, unp. Tortić ( )(2), Schulzer 1857 HR? (1)
Exs.: BEO, CNF
(Lit.: Bas *& al.* 1999, Jacobsson 1991, Moser 1983)

Melanotus Pat.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Moser 1983, Singer 1986, Watling & Gregory 1987)

Melanotus horizontalis (Bull. : Fr.) P.D. Orton
= *Agaricus horizontalis* Bull. : Fr. (1)
= *Phaeomarasmius horizontalis* (Bull. : Fr.) Kühner
= *Psilocybe horizontalis* (Bull. : Fr.) Vellinga et Noordel.
Ref.: Schulzer *&* *al.* 1866 (1)

Phaeomarasmius Scherff.

(Lit.: Arnolds *&* *al.* 1995, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Pilát 1951, Singer 1986)

Phaeomarasmius erinaceus (Fr. : Fr.) Kühner
= *Naucoria erinacea* (Fr. : Fr.) Gillet (1)
Ref.: Focht 1974 (1)

Pholiota (Fr.) P. Kumm.

(Lit.: Arnolds *&* *al.* 1995, Bas *&* *al.* 1999, Bollmann *&* *al.* 1996, Hansen & Knudsen 1992, Holec 2001, Jacobsson 1991, Kreisel 1987, Moser 1983, Singer 1986)

•***Pholiota alnicola*** (Fr. : Fr.) Singer
= *Naucoria amara* (Bull.) ? (1)
= *Pholiota salicicola* (Fr.) Bon
Ref.: Vouk & Pevalek 1916 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Jacobsson 1991)

•***Pholiota astragalina*** (Fr. : Fr.) Singer
Ref.: Tortić 1966 a, Tortić 1993, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF, POZM
(Lit.: Bas *&* *al.* 1999, Jacobsson 1991)

•***Pholiota aurivella*** (Batsch : Fr.) P. Kumm.
= *Agaricus aurivellus* Batsch : Fr. (1)
Ref.: Blagaić 1931, Schulzer *&* *al.* 1866 (1), Škorić 1938, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Tortić 1989, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Hansen & Knudsen 1992, Jacobsson 1991)

Pholiota flavida (Schaeff. : Fr.) Singer
= *Agaricus flavidus* Schaeff. : Fr. (1)
Ref.: Tortić 1973, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF

•***Pholiota gummosa*** (Lasch : Fr.) Singer
Ref.: Barčić 1982, Barčić 1996, Tortić 1968 b, Tortić & Lisiewska 1978, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF
(Lit.: Bas *& al.* 1999, Jacobsson 1991)

•***Pholiota highlandensis*** (Peck) Quadr.
= *Pholiota carbonaria* (Fr. : Fr.) Singer (comb. illeg.) non *P. carbonaria* A.H. Sm. (1)
Ref.: Božac 1984 (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Bas *& al.* 1999, Jacobsson 1991)

•***Pholiota lenta*** (Pers. : Fr.) Singer
Ref.: Božac 1984, Božac 1986, Božac 1989, Božac 1993, Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Jacobsson 1991)

•***Pholiota lubrica*** (Pers. : Fr.) Singer
= *Pholiota decussata* (Fr.) Moser (1)
Ref.: Tortić 1966 a (1), Tortić 1966 b (1), unp. Tkalčec & Mešić, unp. Tortić (1)
Exs.: CNF
(Lit.: Jacobsson 1991)

Pholiota lucifera (Lasch) Quél.
Ref.: Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, unp. Tortić
Exs.: CNF

•***Pholiota populnea*** (Pers. : Fr.) Kuyper et Tjall.-Beuk.
= *Pholiota destruens* (Brond.) Gillet (1)
Ref.: Blagaić 1923 (1), Focht 1986 (1), Vouk & Pevalek 1915 (1), unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Holec 2001, Jacobsson 1991)

Pholiota spumosa (Fr. : Fr.) Singer
Ref.: Tortić 1968 b, unp. Tortić
Exs.: CNF

•***Pholiota squarrosa*** (Weigel : Fr.) P. Kumm.
= *Agaricus squarrosus* Weigel : Fr. (1)
Ref.: Kišpatić 1950, Lisiewska & Tortić 1990, Schulzer *& al.* 1866 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić 1989, unp. Lisiewska, unp. Tkalčec & Mešić, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF, POZM
(Lit.: Bas *& al.* 1999, Jacobsson 1991)

•***Pholiota tuberculosa*** (Schaeff. : Fr.) P. Kumm.
= *Agaricus curvipes* Pers. (1)
Ref.: Schulzer *& al.* 1866 (1), unp. Tkalčec & Mešić

Exs.: CNF
(Lit.: Holec 2001, Jacobsson 1991)

Psilocybe (Fr.) P. Kumm.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Høiland 1978, Kreisel 1987, Moser 1983, Singer 1986, Watling & Gregory 1987)

Psilocybe merdaria (Fr. : Fr.) Ricken
Ref.: Focht 1974

****Psilocybe palmigena*** (Berk. et M.A. Curtis) Sacc.
Ref.: unp. Veselský
Exs.: CNF

Psilocybe semilanceata (Fr.) P. Kumm.
Ref.: Tortić 1973
Exs.: PRM

Stropharia (Fr.) Quél.

(Lit.: Arnolds *& al.* 1995, Bas *& al.* 1999, Bollmann *& al.* 1996, Hansen & Knudsen 1992, Kreisel 1987, Moser 1983, Pilát 1951, Singer 1986, Watling & Gregory 1987)

•***Stropharia aeruginosa*** (Curtis : Fr.) Quél.
= *Agaricus aeruginosus* Curtis : Fr. (1)
= *Psilocybe aeruginosa* (Curtis : Fr.) Noordel.
- as *Agaricus "ceruginosus"* Pers. (2)
Ref.: Schulzer 1857 (1), Schulzer *& al.* 1866 (2) + Schulzer 1867 (1), Tortić 1964, Tortić 1966 a, Tortić 1966 b, Tortić & Lisiewska 1978, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Watling & Gregory 1987)

*•***Stropharia caerulea*** Kreisel
= *Psilocybe caerulea* (Kreisel) Noordel.
Misappl.: *Stropharia cyanea* (Bolton) Tuomikoski sensu auct. non Bolton
(sensu Bolton = *S. aeruginosa* - Kreisel 1987)
Ref.: unp. Matočec, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Watling & Gregory 1987)

•***Stropharia coronilla*** (Bull. : Fr.) Quél.
= *Psilocybe coronilla* (Bull. : Fr.) Noordel.
Ref.: Focht 1974, Gjurašin 1898, Tortić 1964, unp. Matočec, unp. Tkalčec & Mešić, unp. Tortić

Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

•***Stropharia rugosoannulata*** Farl.
Ref.: Focht 1986, unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999, Moser 1983)

Stropharia semiglobata (Batsch : Fr.) Quél.
= *Agaricus semiglobatus* Batsch : Fr. (1)
= *Anellaria semiglobata* (Batsch : Fr.) ? (2)
= *Psilocybe semiglobata* (Batsch : Fr.) Noordel.
= *Agaricus mamillatus* Schulzer (3)
= *Stropharia mamillata* (Schulzer) ? (4)
Ref.: Focht 1974, Schulzer *& al.* 1866 (1), Tortić 1966 a, Tortić 1966 b, Tortić 1968 b, Vouk & Pevalek 1915 (2), unp. Tortić, Fries 1874 HR? (3), Kalchbrenner & Schulzer 1873-1877 HR? (3), Saccardo 1887 HR? (4), Schulzer 1857 HR? (1)
Exs.: CNF

•***Stropharia squamosa*** (Pers. : Fr.) Quél.
= *Agaricus squamosus* Pers. : Fr. (1)
= *Psilocybe squamosa* (Pers. : Fr.) P.D. Orton
Ref.: Božac 1984, Tortić 1968 b, unp. Tortić, Schulzer 1857 HR? (1)
Exs.: CNF

*•var. ***thrausta*** (Schulzer) Massee
= *Psilocybe squamosa* (Pers. : Fr.) P.D. Orton var. *thrausta* (Schulzer) Guzmán
Ref.: unp. Tkalčec & Mešić
Exs.: CNF
(Lit.: Bas *& al.* 1999)

EXCLUDED RECORDS

Family **Crepidotaceae** (S. Imai) Singer

Agaricus albatus Schulzer = **?** [*Crepidotus*]
Ref.: Schulzer 1877, Schulzer *& al.* 1866

Agaricus furfuraceus Pers. : Fr. var. ***sporis-luteis*** Schulzer = **?**
Ref.: Schulzer 1879 a

Agaricus pellucidus Bull. : Fr. var. ***perdebilis*** Schulzer = **?** [*Tubaria*]
Ref.: Schulzer 1879 a

Crepidotus subinteger (Schulzer) Sacc. - nom. dub. (Pilát 1948)
= *Agaricus subinteger* Schulzer (1)
Ref.: Pilát 1948, Saccardo 1887, Schulzer 1882 (1)

Pleurotellus chioneus (Pers.) Kühner
Ref.: Focht 1974
Annotation: Modern authors disagree about the interpretation of this taxon. Some authors consider it an autonomous species (Kreisel 1987, Moser 1983, Singer 1986), some consider it a synonym of *Crepidotus epibryus* (Fr. : Fr.) Quél. (Arnolds *& al.* 1995), while some consider it a doubtful species (Dennis *& al.* 1960, Norstein 1990).

Family **Russulaceae** Roze ex Lotsy

Lactarius argematus (Fr. : Fr.) Fr. var. ***connatus*** Bres. et Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

Lactarius badioalbus Schulzer = **?**
Ref.: Schulzer 1879 a

Lactarius camphoratus (Bull.) Fr. var. ***inolidus*** Schulzer = **?**
Ref.: Schulzer 1881

Lactarius candiculus Schulzer = **?**
Ref.: Schulzer 1879 a

Lactarius cilicioides (Fr. : Fr.) Fr. (rev.) (1)
Ref.: Focht 1972, unp. Matočec
Annotation: This epithet is interpreted in two different senses (for *Lactarius citriolens* Pouzar and for *L. pubescens* Fr. - see Basso 1999). Therefore, without revision it is not possible to know which species the authors have found.

Lactarius cyathula (Fr.) Fr. - nom. ambig.
Ref.: Vouk & Pevalek 1916

Lactarius flexuosus (Pers. : Fr.) Gray
Ref.: Schulzer *& al.* 1866 ?
Annotation: The author himself doubted his identification.

Lactarius medius Schulzer = **?**
Ref.: Schulzer 1881

Lactarius theiogalus (Bull. : Fr.) Gray
= *Agaricus theiogalus* Bull. : Fr. (1)
Ref.: Gjurašin 1898, Kišpatić 1950, Schulzer 1857 (1), Schulzer *& al.*. 1866, unp. Tortić
Annotation: This species has been interpreted in different senses (see Basso 1999, Heilmann-Clausen *& al.* 1998). We do not know which sense has been used by the authors of the records.

Lactarius umbrinus (Pers.) Fr.
Ref.: Škorić 1928
Annotation: This is a doubtful species (Dennis *& al.* 1960).

Russula alba Schulzer = **?**
Ref.: Schulzer 1870

Russula aurantiolutea Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Russula basifurcata Peck
Ref.: Focht 1974
Annotation: This species has been interpreted in different senses (see Sarnari 1998). We do not know which sense has been used by the author of the record.

Russula bifida (Bull.) J. Schröt.
Ref.: Škorić 1928
Annotation: Romagnesi (1967) considers that it could be identical with *Russula heterophylla* (Fr.) Fr.

Russula bresadolae Schulzer
Ref.: Saccardo 1887, Schulzer 1885
Annotation: Romagnesi (1967) considers that it could be identical with *Russula undulata* Velen.

Russula cinnamomicolor Krombh.
Ref.: Schulzer *& al.* 1866, Schulzer 1857 HR?
Annotation: It is a doubtful species (see Romagnesi 1967, Sarnari 1998).

Russula depallens (Pers. : Fr.) Fr.
Ref.: Škorić 1928, Vouk & Pevalek 1916
Annotation: This epithet has been interpreted in different senses (see Romagnesi 1967). We do not know which sense has been used by the authors of the quotes.

Russula diabolica Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Russula furcata (Lam. : Fr.) Fr.
Ref.: Blagaić 1931
Annotation: This epithet has been interpreted in different senses (see Romagnesi 1967). We do not know which sense has been used by the author of the record.

Russula incarnata Quél. var. ***livida*** Bres. = ?
Ref.: Saccardo 1887, Schulzer 1885

Russula inodora Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Russula lactea Pers.
Ref.: Lorinser - Janda 1877, Schulzer *& al.* 1866, Škorić 1928, Vouk & Pevalek 1916
Annotation: According to Romagnesi (1967), most interpretations of this species by older authors are doubtful, therefore we excluded the records.

Russula lactea Pers. var. ***macella*** Schulzer = ?
Ref.: Schulzer 1879 a

Russula linnaei (Fr.) Fr.
Ref.: Vouk & Pevalek 1916

Annotation: According to Vuure (1992), identity of this species is doubtful in the original, Friesian sense. Later, this name has been misapplied in different senses, and we do not know which sense has been used by the author of the record.

Russula livida (Pers.) J. Schröt.
Ref.: Vouk & Pevalek 1916
Annotation: According to Dennis *& al.* (1960) and Romagnesi (1967), the identity of this species is doubtful in the original, Persoon's sense. Since misapplications of this epithet for *Russula heterophylla* (Fr.) Fr. are dated after the record for Croatia, we excluded it.

Russula ochraceoalba Britzelm. = **?**
Ref.: Vouk & Pevalek 1916

Russula ochroleuca Pers. var. ***fraudulosa*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Russula palomet (DC.) ? = **?**
Ref.: Schulzer *& al.* 1866

Russula plumbeocinerea Schulzer = **?**
Ref.: Schulzer 1870

Russula purpurea (Schaeff.) ? = **?**
Ref.: Vouk & Pevalek 1916

Russula purpurina Quél. et Schulzer = **?**
Ref.: Saccardo 1887, Schulzer 1885

Russula queletiana Sacc. = **?**
= *Russula queletii* Schulzer (nom. illeg.) (1)
Ref.: Schulzer 1885 (1), Saccardo 1887 HR?

Russula rugosa Schulzer = **?**
Ref.: Schulzer 1879 a, Schulzer *& al.* 1866 (nom. nud.), Schulzer 1870 HR?

Russula subemetica Schulzer = **?**
Ref.: Schulzer 1881

Russula tincta Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Russula xerampelina (Schaeff.) Fr. var. ***barlae*** (Quél.) Massee
= *Russula barlae* Quél.
Ref.: Lisiewska & Tortić 1990, unp. Tortić
Exs.: CNF
Annotation: According to Arnolds *& al.* (1995) and Bollmann *& al.* (1996) this epithet has been misapplied for two different species (sensu Jul. Schäff. = *Russula faginea* Romagn., sensu Romagn. = *R. cicatricata* Romagn. ex Bon). Since we do not know in which sense the authors of the records have used this name, we exclude it.

Familia **Strophariaceae** Singer et A.H. Sm.

Agaricus adiposoides Schulzer = **?** [*Pholiota*]
Ref.: Schulzer 1879 a

Agaricus agrarioides Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1878

Agaricus amarodulcis Schulzer = **?** [*Flammula*]
Ref.: Schulzer 1877

Agaricus apicreus Fr. var. ***apiculatulus*** Schulzer = **?**
Ref.: Schulzer 1880

Agaricus arrosus Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1877

Agaricus britzelmayri Schulzer = **?** [*Hypholoma*]
= *Agaricus praecox* Pers. : Fr. var. *macrospermus* Schulzer (1)
Ref.: Schulzer 1879 a (1), Schulzer 1881

Agaricus bulbosulus Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1877

Agaricus bullaceoides Schulzer - nom. dub. (Gerhardt 1996)
Ref.: Schulzer 1877
Annotation: According to Gerhardt (1996) this name is a synonym of *Psilocybe coprophila* (Bull. : Fr.) P. Kumm. or *Stropharia semiglobata* (Batsch : Fr.) Quél.

Agaricus caducus Schulzer = **?** [*Hypholoma*]
Ref.: Schulzer 1877

Agaricus carpini-betuli Schulzer = **?** [*Hypholoma*]
= *Agaricus carpini* Schulzer (nom. illeg.) (1)
Ref.: Schulzer 1880 (1), Schulzer 1881, Schulzer *& al.* 1866 (nom. nud.) (1)

Agaricus congestus Schulzer = **?** [*Flammula*]
Ref.: Schulzer 1880

Agaricus dulcamaricans Schulzer = **?** [*Flammula*]
Ref.: Schulzer 1877

Agaricus dulcamaricans Schulzer var. ***populicola*** Schulzer = **?** [*Flammula*]
Ref.: Schulzer 1877

Agaricus insipidus Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1881

Agaricus languide-flavus Schulzer = **?** [*Pholiota*]
Ref.: Schulzer 1877

Agaricus lateritius Schaeff. : Fr. var. ***acrocomatus*** Schulzer - nom. nud.
Ref.: Schulzer *& al.* 1866

Agaricus merdarius Fr. : Fr. var. ***laevis*** Schulzer = **?**
Ref.: Schulzer 1877

Agaricus nigrosporus Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1880

Agaricus nigrosporus Schulzer var. ***nemoreus*** Schulzer = **?** [*Psilocybe*]
Ref.: Schulzer 1880

Agaricus nummus Schulzer = **?** [*Flammula*]
Ref.: Schulzer 1877

Agaricus pulverans Schulzer = **?** [*Pholiota*]
Ref.: Schulzer 1877

Agaricus subarmillatus Schulzer = **?** [*Hypholoma*]
Ref.: Schulzer 1881

Agaricus subrugosus Schulzer = **?** [*Hypholoma*]
Ref.: Schulzer 1878

Agaricus velutiniformis Schulzer - nom. inval.
Ref.: Schulzer 1881

Flammula bresadolae Schulzer = **?**
= *Agaricus vulpecula* Schulzer (nom. illeg.) (1)
Ref.: Saccardo 1887, Schulzer 1877 (1), Schulzer 1885

Hypholoma assimulans Britzelm. = **?**
Ref.: Vouk & Pevalek 1915

Hypholoma elaeodes (Fr.) Gillet
Ref.: Vouk & Pevalek 1915
Annotation: According to Dennis *& al.* (1960) and Watling & Gregory (1987) it could be a synonym of *Hypholoma fasciculare* (Huds. : Fr.) P. Kumm.

Hypholoma fasciculare (Huds. : Fr.) P. Kumm. var. ***obtusum*** (Schulzer) Sacc.
Ref.: Saccardo 1887
Annotation: Author of the quote specified Slavonia (part of Croatia) as a locality, but Schulzer has not described this variety from the territory of Croatia.

Pholiota djakovensis (Schulzer) Sacc. = **?**
= *Agaricus djakovensis* Schulzer (1)
Ref.: Saccardo 1887, Schulzer 1882 (1)

Pholiota magna Sacc. = **?**
Ref.: Saccardo 1887 HR?

CONCLUSION

This Preliminary checklist of Agaricales from Croatia published in five parts, this being the last one, includes all published and most of the unpublished sources of data known to us, published or collected until 1 January 2000. The checklist presents all together 837 species (seven of them in a broad sense), 112 genera and 16 families, of which we have revised 440 species. 106 species and five genera are reported for the first time from Croatia.

We estimate that the overall number of species of the order Agaricales in Croatia is about 3000. Therefore, it is obvious that mycological research in Croatia is still at the beginning. In the last few years mycological field research in Croatia has been intensified under the long-term project of Croatian Mycological Society "Recording and Mapping of Fungi in Croatia".

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LITERATURE CITED

SOURCES OF RECORDED TAXA

Published:

Barčić, B. (1982). Prilog flori gljiva otočića Košljuna. – Acta Bot. Croat. 41: 121-127.
—— (1989). Novi prilog flori gljiva otočića Košljuna. – Acta Bot. Croat. 48: 107-110.
—— (1996). Flora i vegetacija otočića Košljuna. – Franjevački samostan na Košljunu - Punat, Košljun.
Blagaić, K. (1921). Prilozi flori viših gljiva okolice Plitvičkih Jezera. – Glasn. Hrvatsk. Prir. Društva 33(1): 10-44.
—— (1923). Neke naše napomene vrijedne gljive. – Glasn. Hrvatsk. Prir. Društva 35(1-2): 1-15.
—— (1931). Gljive naših krajeva. – Vlastita naklada, Zagreb.
Božac, R. (1982). Gljive naših krajeva. – Grafički zavod Hrvatske, Zagreb.
—— (1984). 600 gljiva naših krajeva. – Mladost, Zagreb.
—— (1986). Gljive - poznavanje i sakupljanje. – Mladost, Zagreb.
—— (1989). Gljive naših krajeva. – Grafički zavod Hrvatske, Zagreb.
—— (1993). Gljive: morfologija, sistematika, toksikologija. – Školska knjiga - Grafički zavod Hrvatske, Zagreb.
Focht, I. (1972). Korčulanske gljive sabrane u prosincu. – Zbornik otoka Korčule (Zagreb) 2: 229-240.
—— (1974). Gljive dubrovačkog kraja. – Dubrovnik (Dubrovnik) 6: 89-102.
—— (1979). Gljive Jugoslavije. – Nolit, Beograd.

Focht, I. (1981). Gljivarski vikend. – Vjesnik, Zagreb.

—— (1983). Sigurnosni gljivarski vikend. – Vjesnik, Zagreb.

—— (1986). Ključ za gljive. – Naprijed, Zagreb.

Forenbacher, A. (1915). Beitrag zur Kenntnis der Pilzflora des Gorski kotar. – Magyar Bot. Lapok 14: 270-275.

Fries, E. (1874). Hymenomycetes Europaei sive epicriseos systematis mycologici editio altera. – Upsaliae. (Reprint: 1937, Dr. Werner Klinkhardt, Leipzig).

Kalchbrenner, K. & S. Schulzer (1873-1877). Icones selectae Hymenomycetum Hungariae. – Pest.

Gjurašin, S. (1898). Gljive iz okolice gospićke. – Nastavni vjesnik (Zagreb) 6: 50-57.

Jelić, M. & M. Tortić (1973). Neke osobitosti flore makroskopskih gljiva u šumi lužnjaka u rezervatu Prašnik. – Acta Bot. Croat. 32: 227-235.

Kišpatić, J. (1950). Prilog poznavanju parasitske mikoflore Hrvatske. – Glasn. Biol. Sekc. II/B, T. 2/3: 44-50.

Kranjčev, R. (1979). Iz svijeta gljiva bilogorsko-podravske regije. – Planinar (Koprivnica) 8: 2-6.

—— (1986). U drugovanju s brezama. – Priroda (Zagreb) 74(7-8): 217-221.

—— (1991). Gljiva na gljivi. – Priroda (Zagreb) 81(5-6): 21.

—— (1995). Priroda Podravine. – Mali Princ, Koprivnica.

Lange, L. (1974). The Distribution of Macromycetes in Europe. – Dansk Bot. Ark. 30(1): 1-105.

Lisiewska, M. (1993). Badania mikosocjologiczne w zespołach leśnych Parku Narodowego Jeziora Plitwickie (Chorwacja). – Wiadom. Bot. 37(3/4): 81-82.

Lisiewska, M. & M. Tortić (1990). Macrofungi in forest associations of the Plitvička jezera National Park (Croatia, Yugoslavia). – Acta Bot. Croat. 49: 81-91.

Lorinser, M. V. - J. Janda (1877). Najvažnije jestive, sumnjive i otrovne gljive. – Sveučilištna knjižara Albrecht i Fiedler, Zagreb.

Mužic, S. & R. Božac (1984). Kuharica sakupljača gljiva. – Mladost, Zagreb.

—— & —— (1997). Kuhanje i ljekovitost gljiva. – Školska knjiga, Zagreb.

Pilát, A. (1948). Monographie des espèces européennes du genre *Crepidotus* Fr. – Atlas des Champignons de l' Europe VI. Musée National, Prague.

Poštenjak, K. (1983). Prilog poznavanju nalazišta *Lactarius semisanguifluus* Heim et Leclair na jugoistočnim padinama Nacionalnog parka "Risnjak". – Šumarski List 107(9-10): 421-424.

Saccardo, P. A. (1887). Sylloge fungorum omnium hucusque cognitorum. V. – Patavii.

Schulzer, S. (1857). Systematische Aufzählung der Schwämme Ungarns, Slavoniens, und des Banates, welche diese Länder mit anderen gemein haben. – Verh. K.K. Zool.-Bot. Ges. Wien 7 (Abh.): 127-152.

—— (1867). Mycologische Miscellen. – Verh. K.K. Zool.-Bot. Ges. Wien 17 (Abh.): 709-730.

Schulzer, S. (1870). Mykologische Beobachtungen aus Nord-Ungarn im Herbste 1869. – Verh. K.K. Zool.-Bot. Ges. Wien 20 (Abh.): 169-210.

—— (1877). Mycologische Beiträge. – Verh. K.K. Zool.-Bot. Ges. Wien 26 (Abh.): 415-432.

—— (1878). Mycologische Beiträge. – Verh. K.K. Zool.-Bot. Ges. Wien 27 (Abh.): 97-116.

—— (1879 a). Mycologische Beiträge. III. – Verh. K.K. Zool.-Bot. Ges. Wien 28 (Abh.): 423-436.

—— (1879 b). Mycologisches. – Flora (Regensburg) 62: 385-391.

—— (1880). Mycologische Beiträge. IV. – Verh. K.K. Zool.-Bot. Ges. Wien 29 (Abh.): 489-506.

—— (1881). Mycologische Beiträge. V. – Verh. K.K. Zool.-Bot. Ges. Wien 30 (Abh.): 487-498.

—— (1882). Deset dana u Djakovu. – Rad Jugoslav. Akad. Znan. 64: 173-183.

—— (1885). Einige neue Pilz-Species und Varietäten aus Slavonien. – Hedwigia 24: 129-151.

Schulzer, S., A. Kanitz & J. A. Knapp (1866). Die bisher bekannten Pflanzen Slavoniens. Ein Versuch. – Verh. K.K. Zool.-Bot. Ges. Wien 16 (Abh.): 3-172.

Stropnik, Z., B. Tratnik & G. Seljak (1988). Naše gobje bogastvo. – Mladinska knjiga, Ljubljana.

Škorić, V. (1928). Mikološki prilog flori Hrvatske i Slavonije sa osobitim obzirom na parasitske gljive. – Glasn. Hrvatsk. Prir. Društva 39-40: 97-108.

—— (1938). Da li je *Pholiota adiposa* Fr. ili *Pholiota aurivella* (Batsch) Fr. uzročnik karakteristične truleži jelova drva? – Glasn. Šumske Pokuse 6: 61-65.

Tortić, M. (1964). Prilog poznavanju viših gljiva okolice Zagreba. – Acta Bot. Croat. 23: 73-100.

—— (1966 a). Makromiceti Gorskog kotara I. – Acta Bot. Croat. 25: 35-50.

—— (1966 b). O rasprostranjenju gljiva u Gorskom kotaru. – Acta Bot. Croat. 25: 21-33.

—— (1968 a). The Mycoflora of Gorski Kotar in Yugoslavia. – Acta Mycol. 4(2): 351-354.

—— (1968 b). Više gljive okolice Zagreba II. – Acta. Bot. Croat. 26-27: 101-116.

—— (1973). Makromiceti Gorskog kotara II. – Acta Bot. Croat. 32: 217-225.

—— (1979). Komparacija flore lignikolnih viših gljiva u dvije šumske asocijacije u nacionalnom parku Plitvička jezera. – *In*: Rauš, Đ. (Ed.), Zbornik drugog kongresa ekologa Jugoslavije. – Savez društava ekologa Jugoslavije, Zagreb. pp. 1133-1141.

—— (1989). Wood-inhabiting agarics and larger ascomycetes in the Plitvice Lakes National park. – Plitvički bilten (Plitvička jezera) 2: 31-38.

Tortić, M. (1993). Macromycetes in mountain Velebit (Croatia). – Acta Bot. Croat. 52: 81-96.

—— (1994). Gljive u Nacionalnom parku "Risnjak". – *In*: Frković, A. (Ed.), Zbornik radova: 40 godina Nacionalnog parka "Risnjak" (1953.-1993.). – Javno poduzeće Uprava Nacionalnog parka "Risnjak", Crni Lug. pp. 78--79.

Tortić, M. & M. Lisiewska (1978). Macromycetes in some chestnut forests in the vicinity of Zagreb. – Acta Bot. Croat. 37: 189-201.

Urbani, M. (1946). Gljive - meso naših šuma. – Poljoprivredna naklada, Zagreb.

Vouk, I. & I. Pevalek (1915). Prilog poznavanju gljiva zagrebačke okoline. – Prir. Istraž. Hrvatske Slavonije 6: 17-25.

—— & —— (1916). Prilog poznavanju bazidiomiceta sjeverne Hrvatske. – Prir. Istraž. Hrvatske Slavonije 8: 18-24.

Vrščaj, D. (1990). Glive: od Triglava do Jadrana. – ČZP Kmečki glas, Ljubljana.

Unpublished:

Kotlaba, F. Notes (according to notes of M. Tortić).

Lisiewska, M. (1969-1989). Notes; in the possesion of the author.

Matočec, N. (1986-1992). Notes; in the possesion of the author.

Tkalčec, Z. & A. Mešić (1984-1999). Notes; in the possesion of the authors.

Tortić, M. (1956-1989). Notes; in the possesion of the author.

—— (1970). Rasprostranjenost nekih lignikolnih viših gljiva u Jugoslaviji s posebnim obzirom na vrste *Armillariella mellea* i *A. tabescens* (Agaricales). Zagreb. Doktorska dizertacija.

Veselský, J. According to data on exsiccatum.

OTHER CITED LITERATURE

Arnolds, E., T. W. Kuyper & M. E. Noordeloos, Eds (1995). Overzicht van de paddestoelen in Nederland. – Nederlandse Mycologische Vereniging, Wijster.

Bas, C., T. W. Kuyper, M. E. Noordeloos & E. C. Vellinga, Eds (1999). Flora agaricina neerlandica. 4. – A. A. Balkema, Rotterdam - Brookfield.

Basso, M. T. (1999). *Lactarius* Pers. – Fungi Europaei 7. Mykoflora, Alassio.

Bollmann, A., A. Gminder & P. Reil (1996). Abbildungsverzeichnis mitteleuropäischer Grosspilze. – Schwarzwälder Pilzlehrschau, Hornberg.

Bon, M. (1980). Clé monographique du genre *Lactarius* (Pers. ex Fr.) S.F. Gray. – Doc. Mycol. 10(40): 1-85.

—— (1988). Clé monographique des russules d'Europe. – Doc. Mycol. 18(70--71): 1-120.

—— (1992). Clé monographique des especes galéro-naucorioïdes. – Doc. Mycol. 21(84): 1-89.

Dennis, R. W. G., P. D. Orton & F. B. Hora (1960). New Check List of Britsh Agarics and Boleti. – Cambridge University Press, London - New York.

Einhellinger, A. (1994). Die Gattung *Russula* in Bayern. – Bibliotheca Mycologica 112. J. Cramer, Berlin - Stuttgart.

Fries, E. (1821). Systema mycologicum. I. – Gryphiswaldiae. (Reprint: 1994, Confederatio Europaea Mycologiae Mediterraneensis A.E., Saronno).

Galli, R. (1996). Le Russule. – Edinatura, Milano.

Gerhardt, E. (1996). Taxonomische Revision der Gattungen *Panaeolus* und *Panaeolina* (Fungi, Agaricales, Coprinaceae). – Biblioth. Bot. 147. E. Schweizerbart'sche Verlagsbuchhandlung (Nägele u. Obermiller), Stuttgart.

Hansen, L. & H. Knudsen, Eds (1992). Nordic Macromycetes. 2. Polyporales, Boletales, Agaricales, Russulales. – Nordsvamp, Copenhagen.

Heilmann-Clausen, J., A. Verbeken & J. Vesterholt (1998). The genus *Lactarius*. – Fungi of Northern Europe 2. Jacob Heilmann-Clausen, Annemieke Verbeken, Jan Vesterholt & The Danish Mycological Society, Oddense.

Høiland, K. (1978). The genus *Psilocybe* in Norway. – Norweg. J. Bot. 25(2): 111-122.

Holec, J. (2001). The genus *Pholiota* in central and western Europe. – IHW-Verlag, Eching.

Jacobsson, S. (1991) "1990". *Pholiota* in northern Europe. – Windahlia 19: 1-86.

Kreisel, H., Ed. (1987). Pilzflora der Deutschen Demokratischen Republik. Basidiomycetes (Gallert-, Hut- und Bauchpilze). – VEB Gustav Fischer, Jena.

Kuyper, T. W. & M. van Vuure (1985). Nomenclatural notes on *Russula*. – Persoonia 12(4): 447-455.

Mešić, A. & Z. Tkalčec (2002). Preliminary checklist of Agaricales from Croatia. II. Families Agaricaceae, Amanitaceae, Cortinariaceae and Hygrophoraceae. – Mycotaxon 83: 453-502.

—— & —— (2003). Preliminary checklist of Agaricales from Croatia IV: Families Bolbitiaceae, Coprinaceae, Entolomataceae and Pluteaceae. – Mycotaxon 87: 283-309.

Moser, M. (1983). Die Röhrlinge und Blätterpilze (Polyporales, Boletales, Agaricales, Russulales). – Kleine Kryptogamenflora IIb/2. Gustav Fischer, Stuttgart - New York.

Neuhoff, W. (1955) "1956". Die Milchlinge (Lactarii). – Die Pilze Mitteleuropas 2b. Julius Klinkhardt, Bad Heilbrunn Obb.

Noordeloos, M. E. & T. W. Kuyper (1999). Notulae ad Floram agaricinam neerlandicam - XXXV: On the typification of *Lactarius necator*. – Persoonia 17(2): 291-294.

Norstein, S. (1990). The genus *Crepidotus* (Basidiomycotina, Agaricales) in Norway. – Synopsis fungorum 2. Fungiflora, Oslo.

Pilát, A., (1951). Klíč k určování našich hub hřibovitých a bedlovitých. – Brázda, Praha.

Rauschert, S. (1989). Nomenklatorische Studien bei höheren Pilzen I. Russulales (Täublinge und Milchlinge). – Česká Mykol. 43(4): 193-209.

Romagnesi, H. (1967). Les Russules d'Europe et d'Afrique du Nord. – Bordas, France.

—— (1985). Les Russules d'Europe et d'Afrique du Nord. – J. Cramer, Vaduz.

Sarnari, M. (1998). Monografia illustrata del Genere *Russula* in Europa. Tomo Primo. – A.M.B., Trento - Vicenza.

Senn-Irlet, B. (1992 a). *Crepidotus* in Nederland. – Coolia 35(1): 1-12.

—— (1992 b). Type studies in *Crepidotus* - I. – Persoonia 14(4): 615-623.

—— (1995). The genus *Crepidotus* (Fr.) Staude in Europe. – Persoonia 16(1): 1-80.

Singer, R. (1986). The Agaricales in Modern Taxonomy. – Koeltz Scientific Books, Koenigstein.

Tkalčec, Z. & A. Mešić (2002). Preliminary checklist of Agaricales from Croatia. I. Families Pleurotaceae and Tricholomataceae. – Mycotaxon 81: 113-176.

—— & —— (2003). Preliminary checklist of Agaricales from Croatia III: Families Boletaceae, Gomphidiaceae and Paxillaceae. – Mycotaxon 87: 255-282.

Vuure, M. van (1992). Checklist van *Russula* in Nederland. – Coolia 35, Suppl.

Watling, R. & N. M. Gregory (1987). Strophariaceae & Coprinaceae pp. – British Fungus Flora: Agarics and Boleti 5. Royal Botanic Garden, Edinburgh.

—— & —— (1989). Crepidotaceae, Pleurotaceae and other pleurotoid agarics. – British Fungus Flora: Agarics and Boleti 6. Royal Botanic Garden, Edinburgh.

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REVISION OF THE FAMILY STEMONITACEAE IN CUBA

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SUMMARY: The material belonging to the family Stemonitaceae in Cuba and deposited mainly in HAJB is reviewed, as well as the scarce and old Cuban material of this family that is deposited in international herbaria. As a result of this revision, 129 collections of nine species are listed. All the species are commented upon and descriptions of two species by interest in the material are included. *Stemonitopsis hyperopta* is new record for Cuba. A Cuban record of *Comatricha elegans* is deleted. The determinations are reinforced by studies of the sporal ornamentation by SEM using the critical point method. Micrographs of the spore ornamentation of species little studied by SEM or that are of particular interest for the island biota are included.

Key words: Myxomycetes, Stemonitales, *Comatricha, Lamproderma, Stemonaria, Stemonitis, Stemonitopsis*, SEM, taxononomy, chorology, Cuba, Neotropics

INTRODUCTION

Studies of Myxomycetes in Cuba began in the first half of the 19th century with the recording of six species by MONTAGNE (1845), two of which belong to the *Stemonitaceae* family: *Stemonitis fusca* and *Stemonitis typhoides* (= *Stemonitopsis typhina*). Further contributions to this group were made by BERKELEY (1869), MASSEE (1892), LISTER (1894), MACBRIDE & MARTIN (1934) and MARTIN (1949). Finally, the revision of FARR (1976) confirms some of these species for the island with four of them belonging to the *Stemonitaceae*: *Comatricha elegans*, *C. typhoides* (= *Stemonitopsis typhina*), *Stemonitis fusca* and *S. splendens*.

Recently, the first author has made additional contributions to the Cuban Myxomycete biota (CAMINO 1991, 1998a, 1998b, 1999, 2002; CAMINO & PEREZ 2000, 2001) using material collected from various localities during several expeditions and has located old Cuban material in other herbaria (BM, BPI, FH, K).

The current work presents a revision of the family *Stemonitaceae* in Cuba based on the presentation made by the authors at the Fourth International Congress of Systematics and Ecology of Myxomycetes (CAMINO & MORENO, 2002).

MATERIALS AND METHODS

The studied material has been collected in the provinces of Pinar del Río, La Habana, Ciudad de la Habana, Matanzas, Camagüey, Cienfuegos, Sancti Spiritus, Granma, Holguín, Santiago de Cuba and Guantánamo. These specimens are deposited in the of Jardín Botánico Nacional Herbarium (HAJB). Old Cuban material revised is deposited in other herbaria (BM, K, BPI, FH).

Samples for light microscopy were mounted in Hoyer's medium and PVA according to SCHNITTLER & NOVOZHILOV (1996) and KOSKE & TESSIER (1983). Spores measurements were made under the oil immersion objective and include surface structure such as spines or warts.

SEM images were prepared using critical point method (CASTILLO *et al.*, 1998) and the micrographs were taken at the University of Alcalá using a Zeiss DSM-950.

A species description is given only if it is either considered of special interest or represents a new record for Cuba.

The terminology of the spore-producing stages follows DÖRFELT & MARX (1990) and LADO & PANDO (1997). The spore wall ornamentation as seen in the SEM is described according to the terminology proposed by RAMMELOO (1975a, b). The abbreviations for author citations follows KIRK & ANSELL (1992).

STUDIED SPECIES

Lamproderma arcyrionema **Rostaf., Sluzowce Monogr. 208 (1874) (Figs. 1-2)**

= *Collaria arcyrionema* (Rostaf.) Nann.-Bremek. ex Lado, *Ruizia* 9:

26 (1991)

Material examined. Pinar del Río, Sierra del Rosario, El Salón, on very humid dead trunk of *Pinus* sp., 7-X-1999, *leg.* M. Benitez, HAJB 8483. **Sancti Spíritus**, Sancti Spíritus, Banao, source of stream Los Leones, 620 m., on very humid rotten trunk, 19-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7840; *Idem*, affluent of the Higuanojo river, to the north of the biological station La Sabina, on petiole of very humid rotten palm, 21-IX-1997, HAJB 7924. **Granma,** Buey Arriba, base of the hillock La Botella, on humid dead trunk 11-V-1988, *leg.* M. Camino, HAJB 5744; Buey Arriba, way to the coast, on very humid rotten wood, 12-V-1988, *leg.* M. Camino, HAJB 5755. **Guantánamo**, Baracoa, next to the Duaba river, way in the ascent to the Yunque de Baracoa, on very humid dead trunk, 17-III-1986, *leg.* M. Camino, HAJB 4790.

Distribution: This species is infrequent in Cuba, nevertheless it appears in four provinces (Pinar del Rio, Sancti Spíritus, Granma and Guantánamo).

Observations. *Lamproderma arcyrionema* is characterized by its sporocarps occurring in groups, stipitate, erect or lightly curved, 1-2 mm high; globose, silvery grey to bronze and iridescent sporotheca, sinuous capillitium and the spores (6-)7-9 µm diam., minutely punctate. By SEM the sporal ornamentation is formed by small bacula.

Lamproderma collinsii T.N. Lakh. & K.G. Mukerji is a closely-related species=described by NANNENGA-BREMEKAMP (1991). The localization and study of the type material of this species would be necessary to delimit the characters for differentiating this species from *L. arcyrionema.*

This species is problably one of he most common species of *Lamproderma* in tropical and subtropical areas (HÄRKÖNEN & SAARIMÄKI, 1991). Reported from Cuba by CAMINO (1998a).

***Lamproderma scintillans* (Berk. & Broome) Morgan, *J. Cincinnati Soc. Nat. Hist.* 16: 131 (1894)**

Material examined. Pinar del Río, Viñales, km 17 Viñales-Pons road, to the right of the bridge of La Caoba river, on humid rotten palm petiole, 29-VI-2000, *leg.* M. Camino, HAJB 8727. **Ciudad de La Habana,** Plaza de la Revolución, Facultad de Biología, on rotten wood, 7-1993, *leg.* H. Notario, HAJB 7107.

Distribution: A rare species in Cuba. We know it only of the most western provinces of the island: Pinar del Río and Ciudad de La Habana.

Observations: *Lamproderma scintillans* is characterized by its globose, silvery blue and iridescent sporotheca, its abundant rigid capillitium, which is pale near the columella, dichotomously branched and very attenuate, pale tips and its minutely verrucose spores of 7-8 µm diam.

CAMINO (2002) is the only record for Cuba, and a new sample has been collected.

***Stemonaria longa* (Peck) Nann.-Bremek., R. Sharma & Y. Yamam., in *Nannenga-Bremekamp, Yamamoto & Sharma, Proc. Kon. Ned. Akad. Wetensch., C* 87 (4): 453 (1984). (Figs. 3-4).**

≡ *Comatricha longa* Peck, *Annual Rep. New York State Mus*. 43: 70 (1890)

Material examined. Pinar del Río, San Cristóbal, Santa Cruz de los Pinos, "Jardín de Aspiro" camp-site, on dead wood, 23-VIII-1987, HAJB 5449; Candelaria, Soroa, way to the viewpoint, on dry stump, 3 -II-1988, *leg*. M. Camino & M. Benítez, HAJB 5663. **La Habana**, Caimito, Sierra de Anafe, Loma del Esperón, Las Auras, on dry dead trunk, 13-VII-89, *leg*. M. Camino & G. Recio, HAJB 6414 and 6415; Mariel, Guajaibón river, on dry bark, 5-VII-1989, *leg*. M. Camino, G. Recio, M. Clavel, M. Benítez & H.D. Gómez, HAJB 6456. **Ciudad de La Habana**, Boyeros, Calabazar, Jardín Botánico Nacional, Pinar, on bark of *Pinus* sp., 27-X-1998, *leg.* M. Clavel, HAJB 8352. **Cienfuegos**, Cumanayagua, Sierra del Escambray, Pico San Juan, on dead trunk, 7-XI-1987, *leg*. M. Rodríguez, HAJB 5562. **Holguín**, Frank País, north hillside of Sierra Cristal, Brazo Grande, 700-800 m., on very humid dead trunk, 10-IV-1987, *leg*. M. Camino & C. Panfet, HAJB 5230; Mayarí, northwest hillside of Sierra Cristal, near to Vega Fresca, on dry dead trunk, 17-IV-1987, *leg*. M. Camino, M. Rodríguez, HAJB 5301.

Distribution: Widespread in the tropics, but rare in the temperate zone (Ing, 1999). This species has an ample distribution in Cuba. We know it from Pinar del Río, La Habana, Cienfuegos and Holguín.

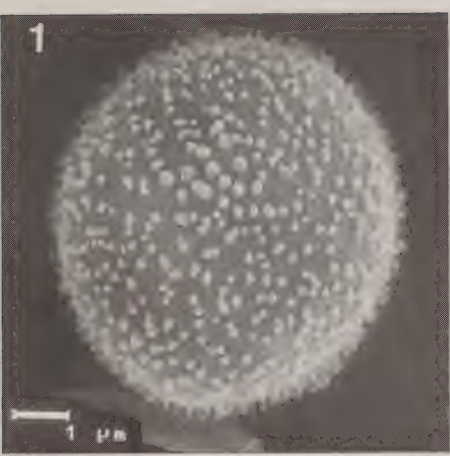
Observations: The long sporocarps reach 20 mm; the large, flexuous and black sporothecae and the capillitium with dichotomously branched filaments with free ends, without a surface net are the most apparent features of *Stemonaria longa*. The spores are to 9-10 µm in diam., verrucose-reticulate and by SEM the spore ornamentation is formed by a reticulum with polyhedric and homogeneous meshes of perforated walls.

This species was reported for Cuba by LISTER (1894) as *Comatricha longa*, which was deposited in Kew Herbarium (K. 1606, C. Wright 261). We studied this material which corresponds with *Stemonitis splendens*, for this reason, the record by CAMINO (1998a) represents the first record of *Stemonaria longa* for Cuba.

Figs. 1-2. - *Lamproderma arcyrionema* (HAJB 8483). 1. Spore. 2. Detail of spore ornamentation.

Figs. 3-4 . - *Stemonaria longa* (HAJB 8352). 1. Spore. 2. Detail of spore ornamentation.

Figs. 5-6. - *Stemonitis axifera* (HAJB 7344). 1. Spore. 2. Detail of spore ornamentation.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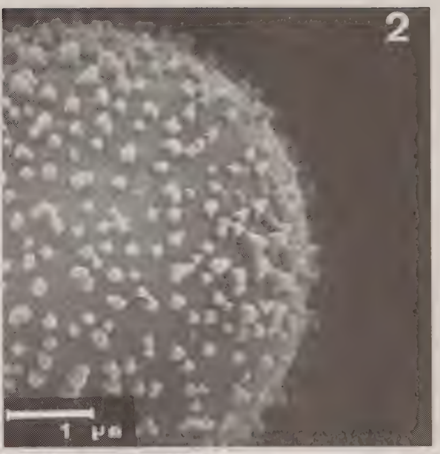
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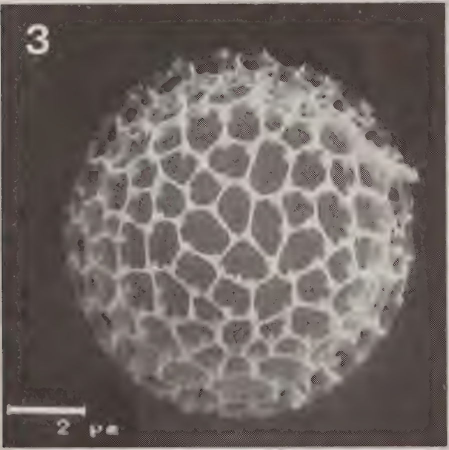
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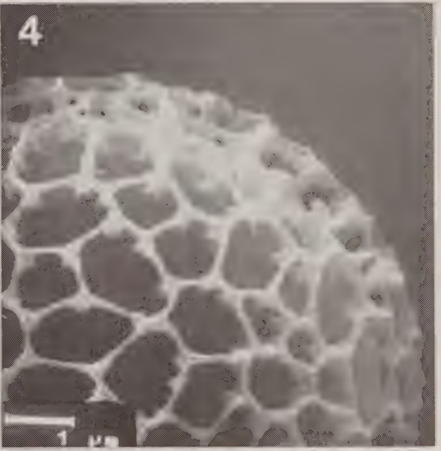
2 µm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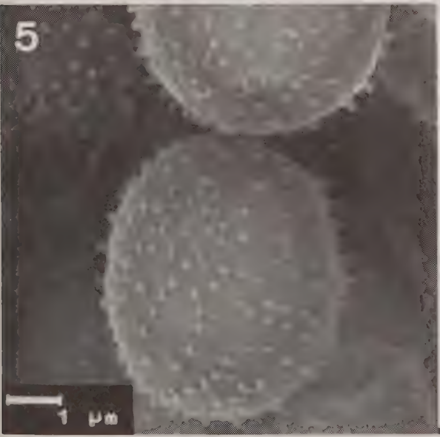
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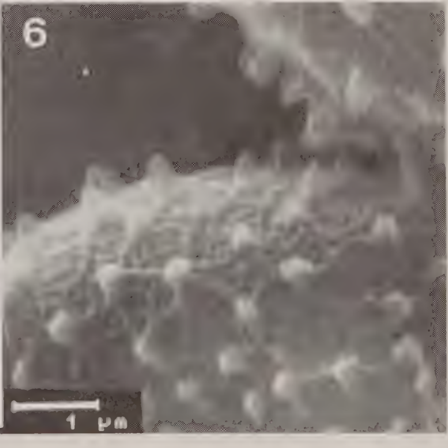
1 µm


6
1 µm

***Stemonitis axifera* (Bull.) T. Macbr. *N. Amer. Slime Moulds*: 120 (1899) (Figs. 5-6)**

≡ *Trichia axifera* Bull., *Herb. France*, pl. 477 (1790)
= *Stemonitis ferruginea* Ehrenb., *Sylv. Myc. Berol*.: 25 (1818)
= *Stemonitis ferruginea* Rostaf.., *Sluzowce Monogr*.: 196 (1874)
= *Stemonitis smithii* T. Macbr., *Bull. Iowa Univ. Lab. Nat. Hist.* 2: 381 (1893)

Material examined. Pinar del Río, Viñales, Cueva del Indio, near to the underground river of the cave, on very humid dead trunk, 19-VI-1991, *leg*. C. Panfet, HAJB 6826; Viñales, km 17 Viñales-Pons road, to the right of the bridge of La Caoba river, on dry dead bark, 29-VI-2000, *leg*. M. Camino, HAJB 8731 and 8734. **Ciudad de La Habana**, Boyeros, Calabazar, Jardín Botánico Nacional, semidecidous forest, on wood, 14-VI-1999, *leg*. M. Benítez, HAJB 8476; *Idem,* on rotten trunk of *Cycas* sp., 14-VI-1999, *leg*. M. Benítez, HAJB 8477; *Idem*, Reparto Trébol, on humid wood, 4-X-1997, , *leg*. W. Alonso, HAJB 7960. **Camagüey**, Sierra de Cubitas, Hoyo de Bonet, on humid dead trunk, 16-V-1995, *leg*. M. Camino & R. Rankin, HAJB 7344. **Cienfuegos**, Cumanayagua, Sierra del Escambray, Pico San Juan, inside of very humid dead trunk of *Roystonea regia*, 7-XI-1987, *leg.* M. Rodríguez, HAJB 5542. **Sancti Spíritus**, Sancti Spíritus, Banao, Los Leones stream, between La Sabina firm and Caja de Agua edge, 620 m., on rotten bark, 19-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7833; Higuanojo river, affluent, to the north of La Sabina house, 620 m., on very humid rotten wood with *Bryophytas*, 21-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7925; *Idem,* way of La Sabina to Hoyo del Naranjal, to 2 km of La Sabina, 500 m.s.m, on humid rotten wood of *Samanea saman*, 20-XI-2001, *leg*. M. Camino, E. Bécquer, D. Minter & J. M. Pérez, HAJB 8952. **Granma,** Buey Arriba, way to La Pata de la Mesa, to the left to La Mesa river and Fajardo country house, on humid dead trunk together to bryophytes, 13-V-1988, *leg*. M. Camino, HAJB 5782; Buey Arriba, way to the coast, on dead humid trunk, 12-V-1988, , *leg*. M. Camino, HAJB 5767; *Idem*, Barrio Nuevo, on dead trunk not very humid, 15-V-1988, *leg*. M. Camino, HAJB 5805.

Sporocarps stipitate, closely tufted, **sporotheca** cylindrical, with pointed apices, bright rusty brown, becoming paler with the spores dispersed, 2-7.5 mm high; **hypothallus** continuous, membranous, reddish brown; **stipe** 1/5 in total height, black, smooth, shining; **peridium** evanescent; **columella** slender and ending below the apex; **capillitium** branching regularly to produce a dense network, surface reticulum smooth, persistent, delicate; **spores** bright reddish brown in mass, 4-6 µm diam., nearly smooth. Under SEM the sporal ornamentation is formed by small warts (bacula) scattered irregularly and surface scrobiculated.

Distribution: Widely distributed in Cuba, we know it from Pinar del Rio, Ciudad de La Habana, Camagüey, Cienfuegos, Sancti Spíritus y Granma.

Observations: *Stemonitis axifera* and *S. smithii* are two very closely related species that have been separated mainly by the size of sporocarps and spores. *S. smithii* has small sporocarps (2-5 mm high) and small spores (4-5 µm diam.), whereas *S. axifera* has somewhat taller sporocarps (5-8 mm high) and spores of greater size (5-7 µm diam.). For this reason *S. smithii* has been treated by some authors (LISTER, 1925; HAGELSTEIN, 1944; FARR, 1976) simply as a variety of *S. ferruginea* or *S. axifera*, whereas other specialists (MARTIN & ALEXOPOULOS, 1969; NANNENGA-BREMEKAMP, 1991; ING, 1999) have considered it to be a good species.

Two of us (GM & AC), after studying numerous samples of these species from different origins, have come to the decision that they correspond with only taxon. These studies are already concluded and will be published shortly.

We have examined the material C. Wright 668 (Berkeley & Curtis Fungi Cub. 539 in FH) indicated by BERKELEY (1869) and verified that it corresponds with *Stemonitis fusca* as already indicated by Sturgis on the specimen label and and as confirmed by FARR (1976).

MASSEE (1892) mentions *Stemonitis ferruginea* Rostaf. for Cuba recorded the erroneous reference by BERKELEY (1869). This species has been reported by CAMINO (1998a, 1999, 2002) and CAMINO & PÉREZ (2001) as *S. smithii*.

***Stemonitis fusca* Roth, *Bot. Mag. (Römer & Usteri)* 1 (2): 26 (1787)**

= *Stemonitis maxima* Schwein., *Trans. Amer. Philos. Soc.* 4: 260 (1832)

Material examined. Pinar del Río, La Palma, Mogote Pico Chico, 6-II-1990, *leg.* C. Panfet, HAJB 6595; Consolación del Sur, Las Guásimas, between Puerta de Golpe and Pilotos, stream of the Ajiconal river, on very humid dead wood, 24-IX-1995, *leg.* M. Camino, HAJB 7427; La Palma, Sagua river, Mil Cumbres road, on dead trunk, 5-II-1996, *leg.* C. Panfet, HAJB 7513; Consolación del Sur, Managuaca, riparian forest, on humid dead trunk, 5-XII-2001, *leg.* M. Camino & J. M. Pérez, HAJB 9017 and 9018. **Ciudad de La Habana**, Plaza, border of Almendares river, on dead branches and leaves of *Poaceae*, 23-I-1988, *leg.* M. Camino & M. Benítez, HAJB 5644; Boyeros, Calabazar, Jardín Botánico Nacional, Pancho Simón stream, 18-I-1988, *leg.* M. Camino & M. Benítez, HAJB 5649; Habana del Este, Alamar, borders of Cojímar river, on very humid rotten trunk, 17-VII-1989, *leg.* M. Benítez & C. Panfet, HAJB 6446, 6447 and 6448; *Idem*, on humid rotten bark, 11-VII-1989, *leg.* M. Benítez & C. Panfet, HAJB 6398; Boyeros, Calabazar, Jardín Botánico Nacional, physiology laboratory, rotten wood, 23-VIII-1995, *leg.* W. Alonso, HAJB 7382; *Idem,* near the laboratory, on humid stump of *Delonix regia*, 27-X-1995, HAJB 7484; *Idem*, on palm raquis, 30-IX-1996, HAJB 7547; *Idem*, on very humid dead trunk, 14-IX-1998, *leg.* J.M. Pérez, HAJB 8103; *Idem,* Pancho Simón stream, on palm petiole, 20-X-1998, *leg.* E. Beltrán, G. Recio, J.L. Rodríguez, J.M. Pérez & M. Clavel, HAJB 8118; *Idem*, on dry leaves, HAJB 8121; *Idem,* on palm petiole, HAJB 8123. **Villa Clara**, Santa Clara, Jardín Botánico de La Universidad, on dead trunk in the shade, 7-XII-1988, *leg.* M. Rodríguez, HAJB 5979. **Sancti Spíritus**, Sancti Spíritus, Banao, hill of Capiro, on humid dead trunk, 27-X-1986, *leg.* M. Camino & M. Rodríguez, HAJB 5105; La Sabina, near the house, 620 m., on dead trunk of *Pinus caribaea*, 18-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7810, 7811 and 7819; Los Leones stream, between La Sabina firm and Caja de Agua edge, 620 m., on dry leaf, 19-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7831; Tetas de Juana, stream in the base, 600 m., on very humid rotten palm petiole, 20-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7892; Higuanojo river, affluent, to the north of La Sabina house, 620 m., on humid rotten shaft of *Piper auritum*, 21-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7910; Tetas de Juana, base, on humid rotten trunk, 5-III-1998, *leg.* J.M. Pérez, HAJB 8057. **Holguín**, Frank País, north hillside of Sierra Cristal, Brazo Grande, 700-800 m., on rotten trunk, 16-IV-1987 *leg.* M. Camino & M. Rodríguez, HAJB 5290. **Santiago de Cuba**, Guamá, La Firmeza, way to Tres Arroyos, on very humid rotten trunk, 25-IV-1989, *leg.* M. Benítez, HAJB 6220. Without locality, *leg.* C. Wright No. 668, (Berkeley & Curtis Fungi Cub. 539 in FH), *det.* Berkeley as *Stemonitis ferruginea* (BERKELEY, 1869). Without locality, *leg.* C. Wright No. 540 in FH, *det.* Berkeley as *Stemonitis typhoides* (BERKELEY, 1869).

Distribution: Abundant and widely distributed in Cuba: Pinar del Río, Ciudad de La Habana, Villa Clara, Sancti Spíritus, Holguín and Santiago de Cuba.

Observations: The reticulated spores is a constant character and easily distinguishable from other species of *Stemonitis*. *S. fusca* is a species very variable morphology in Cuba, with sporocarps 6.5-15 mm high, capillitium with small and scattered to very conspicuous and abundant spines. This species was described in detail with its variations by CASTILLO & al. (1997).

Stemonitis fusca was reported for Cuba by MONTAGNE (1845), MASSEE (1892, as *Stemonitis maxima*) and CAMINO (1998a).

BERKELEY (1869) reported *Stemonitis fusca* from Cuba based on the material of C. Wright 538 (Fungi Cubenses Wrightiani - BM 630), this material was examined and identified by LISTER (1894) as *S. splendens*. We accept Lister's determination of this specimen.

Stemonitis herbatica **Peck, *Ann. Rep. N. Y. State Mus.* 26: 75 (1874) (Figs. 7-8)**

Material examined. Ciudad de La Habana, Boyeros, Calabazar, Jardín Botánico Nacional, on dry stems and leaves of *Zea mays* used for cultivation edible mushroom, 06-1992, *leg*. M. Camino & W. Alonso, HAJB 7090; *Idem*, tree nursery, thorn of Cactaceae, 02-1993, *leg*. E. Hernández, HAJB 7091; *Idem*, Physiology Pavilion, on petiole of rotten leaves of *Microcycas calocoma*, 7-VIII-1996, *leg*. J. Lazcano, HAJB 7544; *Idem*, near the laboratory, on dry leaves of *Terminalia catappa*, 22-IV-1997, *leg*. W. Alonso, HAJB 7687, Boyeros, Reparto Trébol, on stone, 25-IV-1997, *leg*. W. Alonso, HAJB 7688; *Idem*, on leaves of *Scindapsus aureus*, 4-X-1997, HAJB 7961. **Granma**, Guisa, Canarias, Victorino river, on humid rotten trunk, 20-IV-1989, *leg*. M. Benítez, HAJB 6176.

TYPE: USA, New York, Albany, on living leaves, 1246 from N.Y. State coll., BPI 824453.

Distribution: Ciudad de La Habana, Granma.

Observations: This species is characterised by its sporocarps forming small groups, 3.5-6 mm high and sporothecae being cylindrical with a blunt apex. The stipe is short, 1/3-1/5 the total height. The capillitium is moderately dense with a delicate, uniform surface net having meshes similar to the diameter of spores. Spores 7-8 µm diam., finely warted. By SEM the sporal ornamentation is formed by abundant evenly distributed bacula.

In the studied material, most specimens are developed on herbaceous substrates (leaves and stems), one on rotten trunk and another on stone. We have noticed that specimens which have developed on leaves (7090, 7687, 7961) possess an internal net which is more open and less dense and with very few membranous expansions than others found growing on wood (6176, 7091, 7544, 7688) where the sporothecae are also darker in colour due to the presence of the abundant membranous expansions.

Nevertheless, HAGELSTEIN (1936) stated that forms of *Stemonitis herbatica* which have developed on wood, “have more or less the pallid surface net of *S. pallida* and it is more closer to that species, ignoring the shape of the meshes of the surface net and the size of spores”. *S. pallida* differs by regularly developing on wood, having a stipe 1/3 or more of the total height and the surface net tending to be fugacious in the apex (MARTIN, 1949; MARTIN & ALEXOPOULOS, 1969). A taxonomic revision is needed to clarify these subjective differences.

Although *Stemonitis fusca* is lignicolous, we sometimes find this species developing on living plant parts, but its dark sporothecae and its reticulate spores easily distinguish it from *S. herbatica*.

This species was reported for Cuba by CAMINO (1998a).

***Stemonitis splendens* Rostaf., *Sluzowce Monogr.*: 195 (1874)**
Material examined. Pinar del Río, San Cristóbal, Santa Cruz de los Pinos, camping-site "Jardín de Aspiro", on humid dead trunk, 4-VII-1987, *leg.* M. A. Ramírez, HAJB 5347; Candelaria, Las Tumbas, on dead wood, 19-VIII-1987, *leg.* S. Maldonado, R. Rankin & H. D. Gómez, HAJB 5433; Los Hoyos, on dry dead trunk of palm to the sun, 4-II-1988, *leg.* M. Camino & M. Benítez, HAJB 5699. **La Habana**, Caimito, Sierra de Anafe, Esperón hill, Las Auras, on dry dead trunk, 13-VII-1989, *leg.* M. Camino & G. Recio, HAJB 6414. **Ciudad de La Habana**, 10 de Octubre, Lawton, on dead trunk of *Mangifera indica*, 14-VII-1986, *leg.* A. Figueredo, HAJB 5025; Boyeros, Calabazar, Jardín Botánico Nacional, on dry dead trunk, 2-III-1987, *leg.* M. Camino, HAJB 5172; *Idem,* near the Systematics Laboratory, on stopped dead trunk of *Salix babylonica*, 14-III-1990, *leg.* M. Camino, HAJB 6633; *Idem,* Pancho Simón stream, on rotten trunk, 17-III-1990, *leg.* M. Benítez, HAJB 6634; *Idem,* area of plants production, on dry dead trunk, 23-VI-1992, *leg.* W. Alonso, HAJB 7051; *Idem,* near the laboratory, on dry stump, 14-XII-1994, *leg.* E. Arrieta & M. Benítez, HAJB 7314; *Idem,* on dry branches and leaves, 17-VI-1997, *leg.* M. Clavel, HAJB 7684; *Idem,* Physiology Pavilion, on humid stump of *Khaya nyasica*, 27-X-1995, *leg.* W. Alonso, HAJB 7480 and 7481; *Idem,* near the herbaria, on burned trunk of *Cocos nucifera*, 27-X-1995, *leg.* W. Alonso, HAJB 7483; *Idem,* near the laboratory, on humid dead trunk, 28-IX-1998, *leg.* M. Clavel, HAJB 8107; *Idem,* area of cultivated plants, on bark of *Peltophorum inerme*, 27-XI-1999, *leg.* M. Camino, HAJB 8480; *Idem,* on wood of *Orbignya cohune*, 27-XI-1999, *leg.* M. Camino, HAJB 8481; *Idem,* near the physiology laboratory, on dry dead trunk of *Pinus caribaea* 27-XI-1999, *leg.* M. Camino, HAJB 8482; Habana del Este, Alamar, border of Cojímar river, on very humid dead trunk, 13-VII-1989, *leg.* C. Panfet, HAJB 6406; Plaza, Parque Almendares, on rotten trunk, 6-VII-1993, *leg.* O. Rodríguez, HAJB 7094. **Matanzas**, Matanzas, Valle Yumurí, La de Majagua camp, 150 m., on wood, 16-VI-2000, *leg.* A. Riverón, HAJB 8743. **Camagüey**, Sierra de Cubitas, Hoyo de Bonet, on humid dead trunk, 16-V-1995, *leg.* M. Camino & R. Rankin, HAJB 7349, 7352, 7358 and 7366. **Sancti Spíritus,** Sancti Spíritus, Sierra del Infierno, Jarico hill, in the base of burned stump of *Roystonea regia*, 27-X-1986, *leg.* M. Camino & M. Rodríguez, HAJB 5068; Banao, way of Planta Cantú to Cayajaná, on humid dead trunk, 29-X-1986, *leg.* M. Camino & M. Rodríguez, HAJB 5110; *Idem,* on old basidiocarp of *Cerrena maxima*, HAJB 5116; *Idem,* on dead trunk, HAJB 5118; La Sabina, near the house, 620 m., on trunk of *Dichrostachys cinerea*, 18-9-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & J. Calviño, HAJB 7807; *Idem,* on dead trunk of *Eucalyptus*, HAJB 7808. **Granma**, Buey Arriba, Barrio Nuevo, on dry trunk of

Eucalyptus, 10-V-1988, *leg.* M. Camino, HAJB 5724; Guisa, Jardín Botánico de Cupaynicú, 2-VII-1991, *leg.* M. Rodríguez. HAJB 6836. **Santiago de Cuba**, Guamá, way of Las Cuevas del Turquino to La Majagua, a borders of the stream, on very humid dead trunk, 29-X-1986, *leg.* M. Camino, HAJB 5878; El Espejo hill, to the north of Playa Mar Verde and the southwest of El Cobre, on dead branch exposed to the sun, 30-IV-1989, *leg.* M. Benítez & H.D. Gómez, HAJB 6267; Arroyón river, ascent to the hill El Gato, on very humid dead trunk, between leaves, 1-V-1989, *leg.* M. Benítez & H.D. Gómez, HAJB 6290; Santiago de Cuba, ascent to the Gran Piedra, 100 m., on humid dead trunk, 30-6-91, *leg.* M. Rodríguez, HAJB 6830. Without locality, Fungi Cubenses Wrightiani No. 538, Coll. C. Wright, *det.* Lister (LISTER, 1894), BM 630. Without locality, *leg.* C. Wright No. 261, *det.* Lister as *Comatricha longa* (LISTER, 1894), K 1603.

Distribution: Very frequent and widely distributed in Cuba. We have records from Pinar del Río, La Habana, Ciudad de La Habana, Camagüey Sancti Spíritus, Granma, Santiago de Cuba.

Observations: *Stemonitis splendens* is characterized by its dense colonies, large and dark brown sporocarps, capillitium with wide branches that are more or less perpendicular to columella and forming an internal net of numerous meshes and an outer net with meshes larger than the spores. Spores 7-9 µm in diam., with characteristic ornamentation well marked and regularly distributed.

The material of C. Wright 538 (Fungi Cubenses Wrightiani - BM 630) identified as *Stemonitis fusca* by BERKELEY (1869) but revised and identified by LISTER (1894) as *S. splendens* (see observations *S. fusca*). Other material numbered C. Wright 261 (K 1603) was identificated and reported by Lister (1894) as *Comatricha longa*, but after examination of this material, we verified that it corresponds with *Stemonitis splendens*.

This species was reported from Cuba by LISTER (1894), FARR (1976) and CAMINO (1998a), likewise as *Stemonitis webberi* by MACBRIDE & MARTIN (1934), and MARTIN (1949). The records of *S. flavogenita* by CAMINO (1998a, 1999) and CAMINO & PÉREZ (2001), have been re-examined and found to represent *S. splendens*.

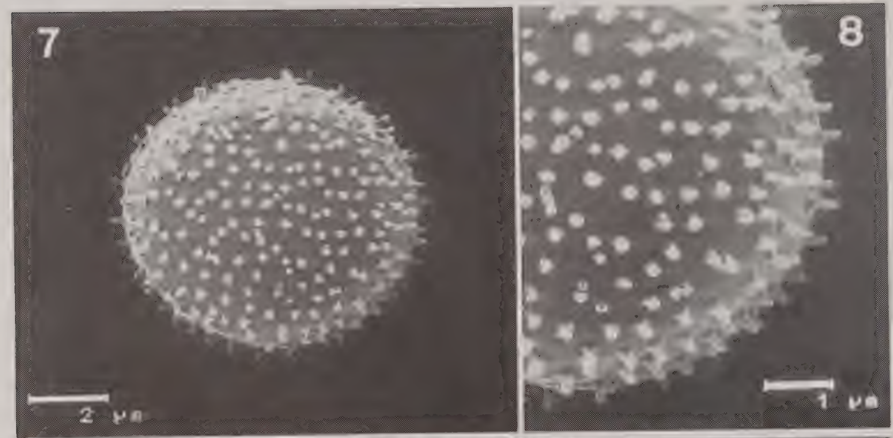
Stemonitopsis hyperopta **(Meyl.) Nann.-Bremek.,** ***Nederlandse Myxomyceten:*** **206 (1975) ["1974"] (Figs. 9-10)**

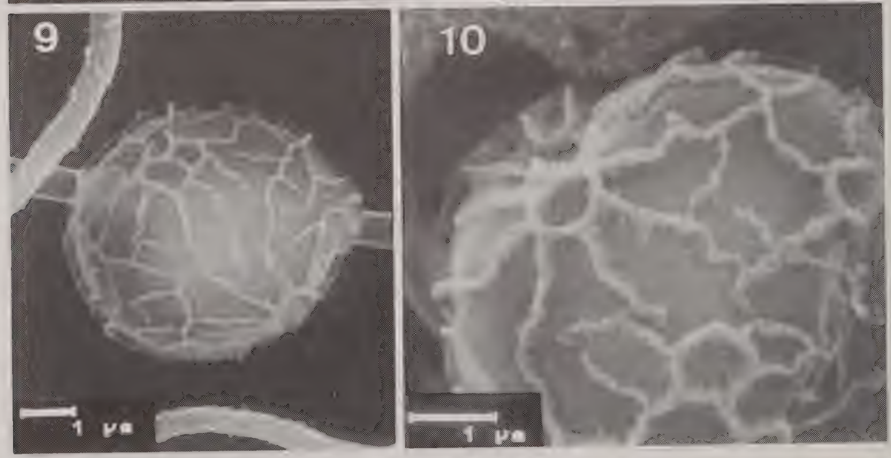
≡ *Stemonitis hyperopta* Meyl. *Bull. Soc. Vaud. Sci. Nat.* 52: 97 (1918)

Material examined. Pinar del Río, Viñales, Viñales–Moncada road, ecoturistic road "Maravillas de Viñales", on very humid dead trunk, 13-I-2002, *leg.* J. M. Pérez, & M. Rodríguez, HAJB 9123.

Sporocarps scattered, stipitate, erect or lightly curved, 3-3.5 mm total height; **sporothecae** cylindrical with obtuse apices; **peridium** fugacious;

hypothallus continuous or circular, membranous, brown; **stipe** 1.5-1.7 mm high, brown, fibrous and reticulate at the base; **columella** ending to a little below the sporotheca apex; **capillitium** reddish-brown, surface net present, fragile, angular meshes usually in the basal part, above usually absent or irregular, the internal net with very few membranous expansions.
Spores black in mass, pale lilac-grey by transmitted light, 5-6 µm diam., very





Figs. 7-8. - ***Stemonitis herbatica* (HAJB 7687).** 1. Spore. 2. Detail of spore ornamentation.
Figs. 9-10. - ***Stemonitopsis hyperopta* (HAJB 9123).** 1. Spore. 2. Detail of spore ornamentation

delicately banded-reticulate. By SEM the spore ornamentation is formed by short crests forming a reticulum with meshes of different size.

Distribution: We have collected this species only in Pinar del Río.

Observations: *Stemonitopsis hyperopta* shows the typical characters the genus cited by NANNENGA-BREMEKAMP (1991) has the fibrous stipe of the genus *Comatricha* and a fragmentary surface net. It is characterized by its small sporocarps and spores with a typical minutely subreticulate ornamentation. Macroscopically this species is very close and easily confused with *Comatricha typhoides*.

Closely related to *Stemonitopsis microspora*, but the latter has smaller spores (3-4.5 µm), grows on leaves, has conical sporothecae and a surface net with sinuose meshes (NANNENGA-BREMEKAMP, 1991).

Stemonitis virginiensis has spores with very similar colour and ornamentation but *Stemonitopsis hyperopta* has larger spores and numerous meshes in the subreticulum of its spores according to MEYLAN (1918). A recent study of the type material of *Stemonitis virginiensis* by SEM has been made by CASTILLO & al. (1997) where it was possible to clearly see the differences in sporal ornamentation of these two species.

This species is a new record for Cuba.

***Stemonitopsis typhina* (F. H. Wigg.) Nann.-Bremek., *Nederlandse Myxomyceten*: 209 (1975) ["1974"].**

≡ *Stemonitis typhina* F. H. Wigg., *Prim. Fl. Holsat.*: 110 (1780)

= *Stemonitis typhoides* (Bull.) DC., in Lamarck & de Candolle, *Fl. Franc.*, ed. 3, 2: 257 (1805)

= *Comatricha typhoides* (Bull.) Rostaf., in Lister, *Monogr. Mycetozoa*: 120 (1894)

Material examined. Pinar del Río, Viñales, Cueva del Indio, near the underground river of the cave, on very humid rotten trunk, 19-VI-1991, *leg.* C. Panfet, HAJB 6825, 6826; Candelaria, highway between Los Tumbos and Los Hoyos, on dead wood, 9-XI-1996, *leg*, R. Rankin, HAJB 7563. **Ciudad de La Habana**, Habana del Este, Alamar, borders of Cojímar river on very humid rotten trunk, 11-7-1989, *leg.* M. Benítez & C. Panfet, HAJB 6395; Boyeros, Calabazar, Jardín Botánico Nacional, physiology pavilion, on humid stump of *Khaya nyasica*, 27-X-1995, *leg.* W. Alonso, HAJB 7479. **Sancti Spíritus**, Sancti Spíritus, Banao, Sierra del Infierno, Jarico hill, 27-X-1986, *leg.* M. Camino & M. Rodríguez, HAJB 5070; Higuanojo river, affluent, to the north of La Sabina house, 620 m., on wood and dry leaves, 21-IX-1997, *leg.* U. Eliasson, M. Camino, E. Bécquer & V.Montriel, HAJB 7914; *Idem*, on humid rotten wood, HAJB 7919. **Holguín**, Frank País, north hillside of Sierra Cristal, Brazo Grande, 700-800 m., on rotten wood, 10-IV-1987, *leg.* M. Camino & M. Rodríguez, HAJB 5228, 5230, 5231, 5288.

Granma, Bayamo, borders of Bayamo river, on very humid rotten trunk, 23-XI-1994, *leg.* M. Benítez, HAJB 7259, 7260. **Santiago de Cuba**, Guamá, way of Las Cuevas del Turquino to La Majagua, borders of the stream, on very humid rotten trunk, 27-V-1988, *leg.* M. Camino, HAJB 5867, 5874 and 5878; *Idem*, La Firmeza, way to Tres Arroyos, on very humid rotten trunk, 25-IV-1989, *leg.* M. Benítez, HAJB 6221.

Distribution: Abundant and widely distributed in Cuba. We have records from Pinar del Río, Ciudad de La Habana, Sancti Spíritus, Holguín, Granma and Santiago de Cuba.

Observations: *Stemonitopsis typhina* has erect sporocarps with obtuse apices and 2.5-5 mm high with fibrous, reddish brown stipe covered with a silvery film. The peridium is silvery and persistent but is often absent in blown sporocarps. Spores 6-7 µm diam., nearly smooth, with a few scattered prominent clusters of warts.

This species was reported from Cuba by MONTAGNE (1845) and by BERKELEY (1869) as *Stemonitis typhoides* (material in bad condition, is *S. fusca*), later it was cited by MASSEE (1892) recorded the erroneous reference by BERKELEY (1869) as *Stemonitis thyphina*. Recently reported by CAMINO (1998a) as *Comatricha typhoides*.

Doubtful material belonging to Stemonitales from Cuba

***Stemonitis pallida* Wingate in Macbride, N. Amer. Slime-Moulds: 123 (1899)**

Material examined. Granma, Buey Arriba, way to La Pata de la Mesa, to the La Mesa river and Finca Fajardo, on humid dead trunk, 13-V-1988, *leg.* M. Camino, HAJB 5783.

ISOTYPE: Ellis & Everhart, N. Am. Fungi 3498, Delaware Co., on rotten wood. Coll. H. Bilgram, BPI 802957.

Distribution: Granma

Observations: The material collected is very sparse and in bad condition and, although it was compared with *typus* material, the record remains doubtful.

The smooth and pale capillitium with ends united to form a delicate surface net are the most apparent features of *Stemonitis pallida*. The spores 5-6 µm in diam, are finely warted.

Reported for Cuba by CAMINO (1998a, 1999).

Excluded taxon of Stemonitales from Cuba

***Comatricha elegans* (Racib.) G. Lister, *Guide Brit. Mycetozoa*, ed. 3:31 (1909)**

Material examined. La Prenda, January, 1923, *leg.* Br. Hioram 6759, *det.*

W.W. Diehl, BPI 821255

Observations: This species is reported for Cuba only in the Flora Neotropica (FARR, 1976) without indicating the specimen number. We have examined the material, deposited in BPI, and found it to correspond with *Physarum nucleatum* Rex.

As we know of no other record from the island, we suggest that this species be excluded from the Cuban list.

CONCLUSIONS

1. - The taxonomic study of the family Stemonitaceae in Cuba enabled the recognition of nine species of the genera *Lamproderma* (2), *Stemonaria* (1), *Stemonitis* (4) and *Stemonitopsis* (2).

2. - The record of *Stemonitopsis hyperopta* is new for Cuba.

3. - The published record of *Comatricha elegans* (FARR, 1976) is excluded for Cuba after studying the material deposited in BPI herbarium because the specimen corresponds to *Physarum nucleatum*. Although species of *Comatricha* have not yet been found in Cuba, it is very likely that members of this genus will be collected because of it is abundance throughout the Neotropics.

4. - The specimen of *Stemonitis pallida* is indicated as doubtful, due to the poor condition of the material which does not allow microscopic study.

5. - The records of *Stemonitis axifera* and *S. smithii* are considered here as being synonymous and are included under *S. axifera*.

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BIBLIOGRAPHY

BERKELEY, M.J. (1869). On a collection of fungi from Cuba. Part II. *J. Linn. Soc. Bot.* 10: 341-392.

CAMINO, M. (1991). Myxomycetes de Cuba I. *Revista Jard. Bot. Nac. Univ. Habana* 12: 127-131

CAMINO, M. (1998a). Myxomycetes de Cuba . II. Orden Stemonitales. *Revista Jard. Bot. Nac. Univ. Habana* 19: 147-153.

CAMINO, M. (1998b). Los Myxomycetes del Hoyo de Bonet, Sierra de Cubitas, Camagüey. *Revista Jard. Bot. Nac. Univ. Habana* 19:161-162.

CAMINO, M. (1999). *La familia Stemonitaceae (Myxomycetes) en Cuba*. Tesis en opción al grado académico de Master en Botánica, Mención Micología. Jardín Botánico Nacional. Universidad de La Habana.

CAMINO, M. (2002). Nuevos registros de la familia Stemonitaceae (Myxomycetes) para Cuba: *Lamproderma scintillans* y *Stemonitis smithii*. *Revista Jard. Bot. Nac. Univ. Habana* 23: 85-89.

CAMINO, M. & G. MORENO (2002). The family Stemonitaceae in Cuba: current state of studies. *Abstr. 4th. Intern. Congr. Syst. Ecol. Myxomycetes*: 11.

CAMINO, M. & J.M. PÉREZ (2000). El género *Arcyria* Wiggers (Trichiales - Myxomycetes) en Cuba. *Revista Jard. Bot. Nac. Univ. Habana* 21 (1): 115-126.

CAMINO, M. & J.M. PÉREZ (2001). Los Myxomycetes de la Reserva Ecológica "Alturas de Banao" (El Naranjal) Sancti Spíritus. *Revista Jard. Bot. Nac. Univ. Habana* 22 (1): 109-117.

CASTILLO, A., G. MORENO, C. ILLANA & J. LAGO (1997). A critical study of some Stemonitales. *Mycol. Res.* 101: 1329-1340.

CASTILLO A., C. ILLANA & G. MORENO (1998). *Protophysarum phloiogenum* and a new family in the Physarales. *Mycol. Res*. 102: 838-842.

DÖRFELT, H. & H. MARX (1990). Zur Terminologie der sporenbildenden Stadien der Myxomyceten. *Beitr. Kenn. Pilze Mitteleurop.* 6: 5-14.

FARR, M.L. 1976. *Myxomycetes*. In: Flora Neotropica 16. Cramer, N. Y. 304 pp.

HAGELSTEIN, R. (1936). A critical study of the Mycetozoa of Long Island. *Mycologia* 28: 547-623

HAGELSTEIN, R. (1944). *The Mycetozoa of North America.* Mineola, New York. 306 pp.

HÄRKÖNEN, M & T. SAARIMÄKI (1991). Tanzanian Myxomycetes: first survey. *Karstenia* 31: 31-54.

ING, B. 1999. *The Myxomycetes of Britain and Ireland. An Identification Handbook.* The Richmond Publishing Co. Ltd. England. 374 pp.

KIRK, P.M. & A.E. ANSELL (1992). *Author of fungal names. A list of authors of scientific names of fungi, with recommended standard forms of their names, including abbreviations.* Index of fungi supplement. C.A.B. International, Wallingford, UK. 95 pp.

KOSKE, R.E. & B. TESSIER (1983). A convenient permanent slide mounting medium. *Mycol. Soc. Amer. Newsletter* 34: 59.

LADO, C & F. PANDO (1997). *Flora Mycologica Iberica. Vol. 2. Myxomycetes, I. Ceratiomyxales, Echinosteliales, Liceales, Trichiales*. Real Jardín Botánico Madrid, J. Cramer 323 pp.

LISTER, A. (1894). *A monograph of the Mycetozoa, being a descriptive catalogue of the species in the Herbarium of the British Museum.* British Museum (Nat. Hist.) Cromwell road, London 224 pp.

LISTER, A. (1925). *A monograph of the Mycetozoa. A descriptive catalogue of the species in the Herbarium of the British Museum* (Ed. 3. Rev. G. Lister). British Museum. London. 296 pp.

MACBRIDE, T.H. & G.W MARTIN (1934). *The Myxomycetes. A descriptive list of the known species with special reference to those occurring in North America.* The MacMillan Company, N.Y. 339 pp.

MARTIN, G.W. (1949). Fungi Myxomycetes Ceratiomyxales, Liceales, Trichiales, Stemonitales, Physarales. *North. Am. Fl.* 1: 1-151.

MARTIN, G.W. & C. J. ALEXOPOULOS (1969). *The Myxomycetes.* Univ. Iowa Press, Iowa City. 561 pp.

MASSEE, G. (1892). *A monograph of the Myxogastres*. Methuen & Co. London. 367 pp.

MEYLAN, C. (1918). Myxomycètes nouveaux. *Bull. Soc. Vaud. Sci. Nat.*, 52: 95-97.

MONTAGNE, J.F.C. (1845). *Criptogamia o plantas celulares*. In: Sagra, R. de la (ed.) Historia física, política y natural de la Isla de Cuba IX : 153-256.

NANNENGA-BREMEKAMP, N.E. (1991). *A guide to temperate Myxomycetes*. Biopress Limited. Bristol. 403 pp.

RAMMELOO, J. (1975a.) Structure of the epispore in the Stemonitales (Myxomycetes) as seen with the scanning electron microscope. *Bull. Jard. Bot. Belg.* 45: 301-306.

RAMMELOO, J. (1975b). Structure of the epispore in the Trichiaceae (Myxomycetes) as seen with the scanning electron microscope. *Bull. Soc. Roy. Bot. Belgique*. 107: 353-359.

RAMMELOO, J. (1983). *Flore Illustrée des Champignons d´Afrique Central. Echinosteliales et Stemonitales (Myxomycetes)*. Fascicule 11. Jardin Botanique National de Belgique. Meise. Bélgica.

SCHNITTLER, M & Y. NOVOZHILOV (1996). The Myxomycetes of boreal woodlands in Russian northern Karelia: a preliminary report. *Karstenia* 36: 19-40.

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NEW SPECIES OF LACTARIUS FROM KUMAON HIMALAYA, INDIA

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ABSTRACT

Three taxa of the genus *Lactarius* (Russulaceae), viz., *Lactarius dwaliensis*, *L. maitlyensis* and *L. dafianus* from Kumaon Himalaya (Indian subcontinent), are proposed as new species. Macro and micromorphological characters of these species are described and illustrated, and ecological data are provided.

Key words: Russulaceae, ectomycorrhiza

INTRODUCTION

Northwestern Himalayan forests have an amazing Russulaceae diversity due to the vast range of microclimates, habitats and ectomycorrhizal hosts. In India, the genus *Lactarius* has received attention from Watling & Gregory (1980), Abraham & Kaul (1985), Saini & Atri (1982), Atri & Saini (1986), Bhatt & Lakhanpal (1990), Atri *et al.* (1993, 1994), Bhatt *et al.* (1999, 2000), Das & Sharma (2001) and Rawla (2002). While foraying into the Kumaon Himalayan forests intensively from 1998 to 2001, the authors came across three specimens which, after thorough microscopic study and literature survey, appear to represent undescribed species.

MATERIAL AND METHODS

Macroscopic characters were recorded on fresh materials. Free hand sections of the dried specimens were mounted in 5% KOH, Melzer's reagent, lactophenol-cotton blue, Congo-red and Carbol Fuchsin for microscopic characterization, measurements and drawings of microstructures. For measurement of spores, ***n*** number of spores were taken and '**Q**' value (**L/W** ratio) was calculated by considering the mean value of length and width. Macromorphological line-drawings were made by K. Das based on fresh materials whereas microscopic line drawings were prepared subsequently by A. Verbeken and K. Das with the aid of a drawing tube and camera lucida.

Spores for scanning electron microphotographs were obtained from gill samples which were pretreated gradually in acetone-alcohol and acetone and mounted on double faced adhesive tape. Spores were coated with a layer of gold-paladium and observed under PHILIPS PSEM 515 HOLLAND. Colour terminology is after Kelly & Judd

(1955). Herbaria housing the cited collections are abbreviated in accordance with Holmgren *et al.* (1990).

RESULTS AND DISCUSSION

Lactarius dwaliensis K.Das, J. R. Sharma & Verbeken **sp. nov.** (Figs. 1, 4A)

Etymology: From the name of the Dwali Forest Range, referring to the type locality.

Pileus 84-130 mm diam., convexus, ad planoconvexus, albus, siccus, glabrous, margine decurvato, umbilicatus ad depressus in centro. Lamellae subdecurrentes ad decurrentes, moderate distantes, flavido-albidae. Stipes 50-145 x 17-30 mm, cylindricus, albus vel luteoalbus. Latex albus, lente pallide viridoflavus. Sporae in cumulo albae, (7.6) 8-10.5 x 7.2-8.6 µm, subglobosae ad late ellipsoidae, amyloideae, irregulariter verrucosae. Pleuromacrocystidia 45-65 x 4-7 µm, abundantia, cylindrica. Pleuropseudocystidia rara. Cheilomacrocystidia 40-55 x 5-7 µm, cylindrica. Pileipellis bistrata; suprapellis ex hyphis repentibus, subpellis pseudoparenchymata. ***Typus****: India: Uttaranchal, Bageswar, Dwali (2300 m), 3rd Oct. 1999, K. Das, KD612 (BSD-Holotypus; GENT-Isotypus).*

Pileus 84-130 mm diam., convex with decurved margin, planoconvex to umbilicate with depressed center when mature; pileipellis dry, shiny, glabrous, azonate, white. *Lamellae* subdecurrent to decurrent, rather distant (*ca* 3-4 per cm) with 3 rows of lamellulae, yellowish white. *Stipe* 50-145 x 17-30 mm, cylindrical, white to yellowish white. Context white, gradually light greenish yellow when bruised. *Latex* copious, white, slowly becoming light greenish yellow on exposure. Spore print white.

Spores (7.6) 8-10.5 x 7.2-8.6 µm ($n = 20$, Q = 1.00-1.20), subglobose to broadly ellipsoid; ornamentation amyloid, up to 0.5 µm high, composed of irregular warts, often aligned and connected; plage inamyloid. *Basidia* 45-55 x 9-11 µm, cylindric to subclavate, 4-spored. *Pleuromacrocystidia* 45-65 x 4-7 µm, abundant, narrowly cylindric, with rounded or slightly tapering apices and granular contents. *Pleuropseudocystidia* 50-70 x 4-6 µm, scarce, cylindric to subclavate, sometimes with mucronate apices. Lamellae edge sterile; marginal cells 20-30 x 4-7 µm. *Cheilomacrocystidia* 40-55 x 5-7 µm, cylindric with acute apices and needle like contents. Subhymenial layer up to 22 µm thick. Hymenophoral trama cellular, composed of abundant sphaerocytes with some hyphae; lactifers, up to 10 µm broad. *Pileipellis* two layered; subpellis up to 125 µm thick, composed of globose to subglobose cells of 10-40 µm diam.; suprapellis 30-50 µm thick, composed of mostly repent hyphae; hyphae thin-walled, frequently septate, 3-4 (6) µm broad.

Additional specimens examined: India: Uttaranchal, Bageswar, Khati, 2000 m, on ground, associated ectomycorrhizally with *Quercus leucotrichophora* A. Camus, 5th Oct. 1999, *K. Das & J.R. Sharma*, KD698 (BSD).

Lactarius dwaliensis is a rare species and grows gregariously in close association with *Quercus leucotrichophora* in temperate deciduous forests of Kumaon Himalaya.It can easily be distinguished in the field by white, smooth, shiny pileus with usually long, white stipe, white context, distant lamellae and the white latex changing to greenish yellow on exposure. Microscopically the two layered pileipellis with suprapellis of

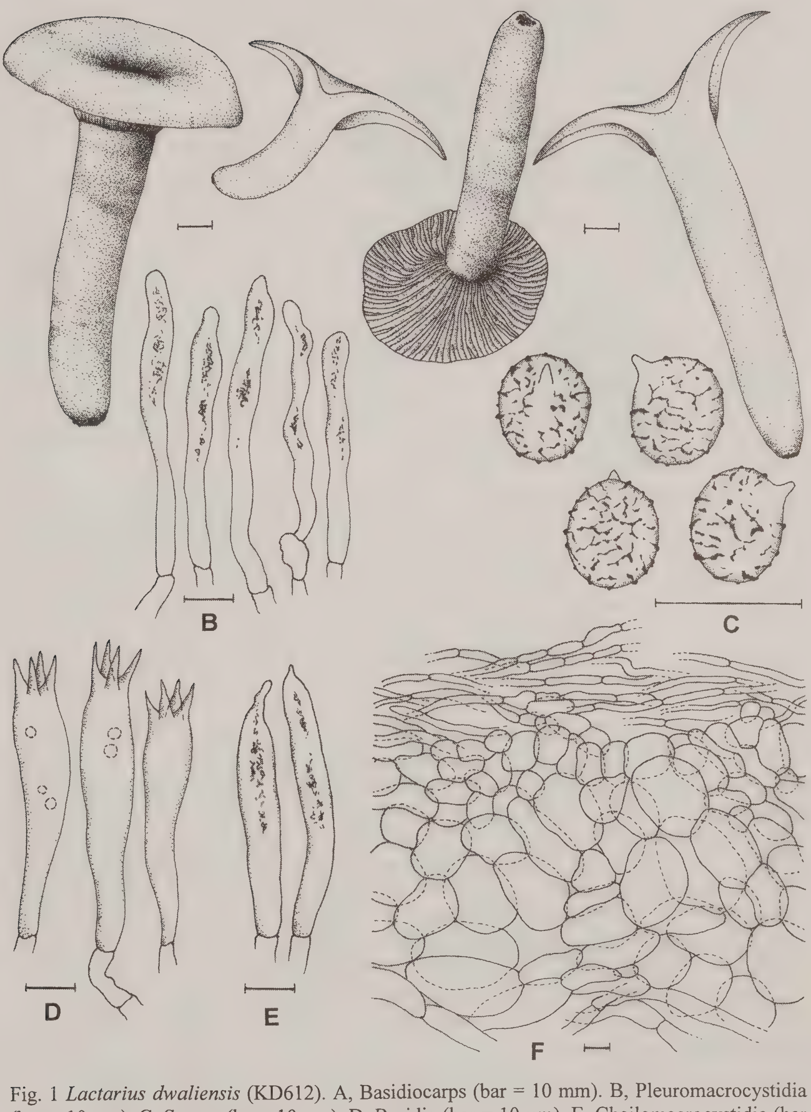

Fig. 1 *Lactarius dwaliensis* (KD612). A, Basidiocarps (bar = 10 mm). B, Pleuromacrocystidia (bar = 10 µm). C, Spores (bar =10 µm). D, Basidia (bar = 10 µm). E, Cheilomacrocystidia (bar = 10 µm). F, Pileipellis (bar = 10 µm).

repent hyphae and cellular subpellis, is very distinct. The combination of characters places the species in the subgenus *Lactarius* (sensu Heilmann-Clausen *et al.* 1998), where it reminds *L. piperatus* (L.: Fr.) Pers. and related species.

Lactarius dwaliensis differs from *L. subpiperatus* Hongo because the latter has smaller basidiocarps and smaller spores (6-7.5 x 5-6 µm) and lacks pleuromacrocystidia (Hesler & Smith 1979). *L. neuhoffii* Hesler & A.H. Sm. seems most closely related to the proposed new taxon, but differs by the denser lamellae, shorter stipe (30-50 mm) and the more velvety basidiocarps (Hesler & Smith 1979).

Lactarius maitlyensis K.Das, J. R. Sharma & Verbeken **sp. nov.** (Figs. 2, 4B);

Etymology. From the name of the village Maitly, referring to the type locality.

Pileus 40-70 mm diam., convexus ad applanatus, leviter depressus in centro, viscidus, interdum leviter zonatus, griseus ad griseofulvus, margine decurvato. Lamellae immarginatae ad adnatae, subdistantes ad moderate densae, luteo-albidae. Stipes 38-50 x 7-10 mm, teretiusculus, albus ad luteus, base luteo alba. Latex albus, lente pallide galbanus. Sporae in cumulo luteoalbae, 6.5-8 x 5.7-6.7 µm, globosae ad late ellipsoidae, amyloideae, zebroideae. Pleuromacrocystidia 50-90 x 9-14 µm, abundantia, subclavata vel fusiformia. Pleuropseudocystidia cylindrica. Cheilomacrocystidia nulla. Pileipellis ex hyphis hyalinis dense intertextis ixocutem formantibus. ***Typus****: India: Uttaranchal, Pithoragarh, Maitly (1500 m), 2nd Oct. 2001, K. Das et J.R. Sharma, KD4030 (BSD-Holotypus; GENT-Isotypus).*

Pileus 40-70 mm diam., convex, applanate with slightly depressed center when mature; pileipellis viscid, faintly zonate to azonate, greyish to deep grey-reddish brown with pale yellow areas and darker center; margin decurved, somewhat wavy. *Lamellae* adnate to emarginate, subdistant to rather dense (*ca* 4-5 per cm), with two rows of lamellulae, yellowish white to pale yellow. *Stipe* 38-50 x 7-10 mm, subcylindric or tapered towards base, yellowish white, grey-yellowish brown towards base. Context firm, yellowish white becoming dingy slowly. *Latex* white, becoming light greenish yellow on exposure. Spore print yellowish white.

Spores 6.5-8 x 5.7-6.7 µm (*n* = 20, Q = 1.02-1.21), globose to broadly ellipsoid; ornamentation amyloid, up to 1.5 µm high, composed of ridges and warts in a distinct zebra-like pattern; ridges often with a somewhat knotty aspect; plage not or very slightly distally amyloid. *Basidia* 35-50 x 10-13 (-14) µm, clavate, 4-spored, with rather long sterigmata (up to 11 µm). *Pleuromacrocystidia* 50-90 x 9-14 µm, abundant, emergent up to 35 µm, irregularly subclavate to fusiform, apices subacute to often very long and narrow, with needle-like contents. *Pleuropseudocystidia* moderately abundant, cylindric, but often with very irregular, knotty apices, 3-4 µm broad. Lamellae edge sterile; marginal cells 25-40 x 4-7 µm, subclavate to fusoid or cylindric. *Cheilomacrocystidia* absent. *Cheilopseudocystidia* 25-40 x 4-7 µm, subclavate to fusoid. Hymenophoral trama cellular with sphaerocytes and hyphae, lactifers abundant, up to 10 µm thick. *Pileipellis* an ixocutis, up to 150 µm thick, composed of thin, 3-4 µm broad, hyaline hyphae.

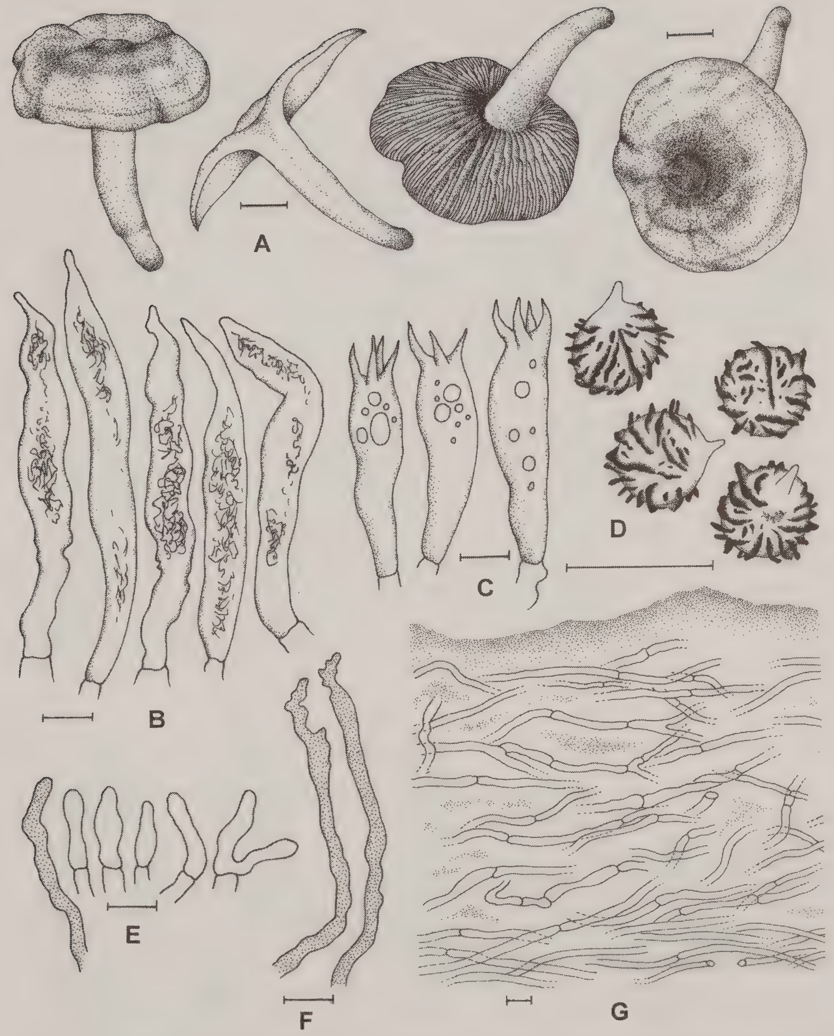

Fig. 2 *Lactarius maitlyensis* (KD4030). A, Basidiocarps (bar = 10 mm). B, Pleuromacrocystidia (bar = 10 μm). C, Basidia (bar = 10 μm). D, Spores (bar = 10 μm). E, marginal cells (bar = 10 μm). F, Pleuropseudocystidia (bar = 10 μm). G, Pileipellis (bar = 10 μm).

Additional specimens examined: India: Uttaranchal, Pithoragarh, Maitly-top, 1700 m, on ground, ectomycorrhizally associated with *Q. leucotrichophora*, 3rd Oct. 2001, *K. Das & J.R. Sharma*, KD4034 (BSD).

This is not a common species in Kumaon Himalaya. Basidiocarps grow in gregarious to caespitose fashion forming ectomycorrhizal association with *Quercus leucotrichophora* in the subtropical mixed Himalayan forests (1500-2000 m).

Lactarius maitlyensis is characterized morphologically by a faintly zonate to azonate greyish brown pileus, white latex, changing to lemon yellow on exposure. Microscopically, zebroid spores, irregularly subclavate to fusiform macrocystidia with needle-like contents and a pileipellis of ixocutis arrangement are also very characteristic.

Lactarius maitlyensis belongs to subgenus *Piperites* (Fr.) Kauffman, section *Glutinosi* Qu_l., subsection *Pyrogalini* Singer and resembles *L. pyrogalus* (Bull.: Fr.) Fr. and *L. flexuosus* (Pers. : Fr.) Gray, both European species. Distinctly zonate pileus, smaller spores (5.2-7.7 x 4.5-6.2 µm), and pleurocystidia with acute to mucronate apices without needle-like contents (Heilmann-Clausen *et al.* 1998) separate *L. pyrogalus* from the present taxon. Similarly, larger (30-110 mm) basidiocarps, unchanging white latex, larger spores (6-8.6 x 5-6.9 µm) and regularly shaped pleurocystidia without needle-like contents (Heilmann-Clausen *et al.* 1998), are the characters which separate *L. flexuosus* from *L. maitlyensis*.

Moreover, the present species also shares some features with *L. xanthogalus* Verbeken & E. Horak and *L. cristulatus* Montoya & Bandala, both having spores with zebroid ornamentation patterns. *L. xanthogalus* even has white latex, which immediately changes to sulphur yellow on exposure and subglobose to broadly ellipsoid spores (Q = 1.16-1.23 in average) (Verbeken & Horak 2000). *L. xanthogalus*, however, differs in colour of basidiocarps, which are "orange-yellow, evenly orange, with age gradually changing to paler concolourous, cream-coloured or whitish" and the larger spores, 8.8-9.8 x 7.5-7.9 µm in average (Verbeken & Horak 2000). *L. cristulatus* has basidiocarps which are grey in colour, although these tend to present olivaceous tinges, the latex is invariable and the spores are definitely more ellipsoid "... 'Q' = 1.26-1.38..." (Montoya & Bandala 2003).

Lactarius dafianus K. Das, J. R. Sharma & Verbeken **sp. nov.** (Figs. 3, 4C & 4D);

Etymology. From the name of the Dafia Forest Range, referring to the type locality.

Pileus 65-75 mm diam., convexus, ad applanatus depressusque, rubroaurantiacus, zonatus. Lamellae immarginatae ad subdecurrentes, furcatae, pallide luteoroseae. Stipes 25-32 x 8-11 mm, cylindricus, rubrobrunneus ad fulvobrunneus. Latex aquosus albus. Sporae 7.7-9.5 x 5.9-6.7 µm, ellipsoideae, amyloideae, verrucosae ad incomplete reticulatae. Pleuromacrocystidia 55-84 x 6-11 µm, abundantia, fusiformia. Cheilomacrocystidia 54-70 x 5-10 µm, lanceolata vel fusiformia. Pileipellis ex hyphis cylindraceis trichodermium formantibus. ***Typus****: India: Uttaranchal, Pithoragarh, Dafia Dhura (2300 m), 3rd Oct. 2001, K. Das, KD4059 (BSD-Holotypus; GENT-Isotypus).*

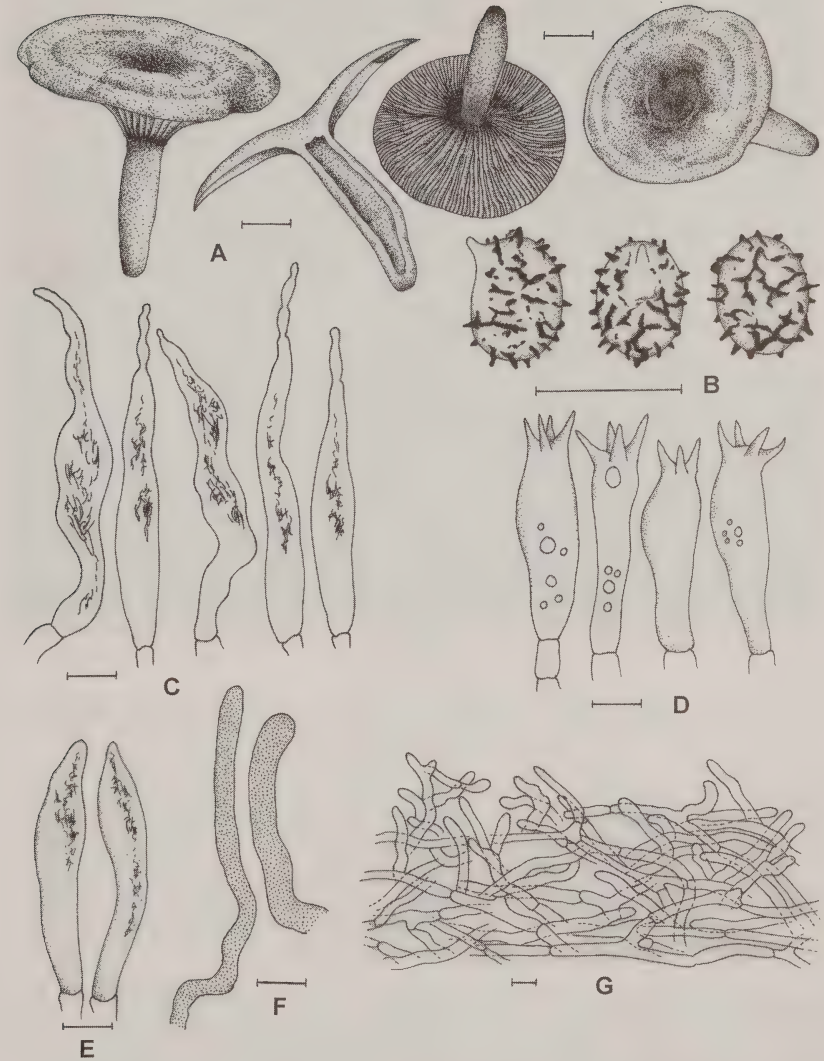

Fig. 3 *Lactarius dafianus* (KD4059). A, Basidiocarps (bar = 10 mm). B, Pleuromacrocystidia (bar = 10 μm). C, Spores (bar = 10 μm). D, Basidia (bar = 10 μm). E, Cheilomacrocystidia (bar = 10 μm). F, Pseudocystidia (bar = 10 μm). G, Pileipellis (bar = 10 μm).

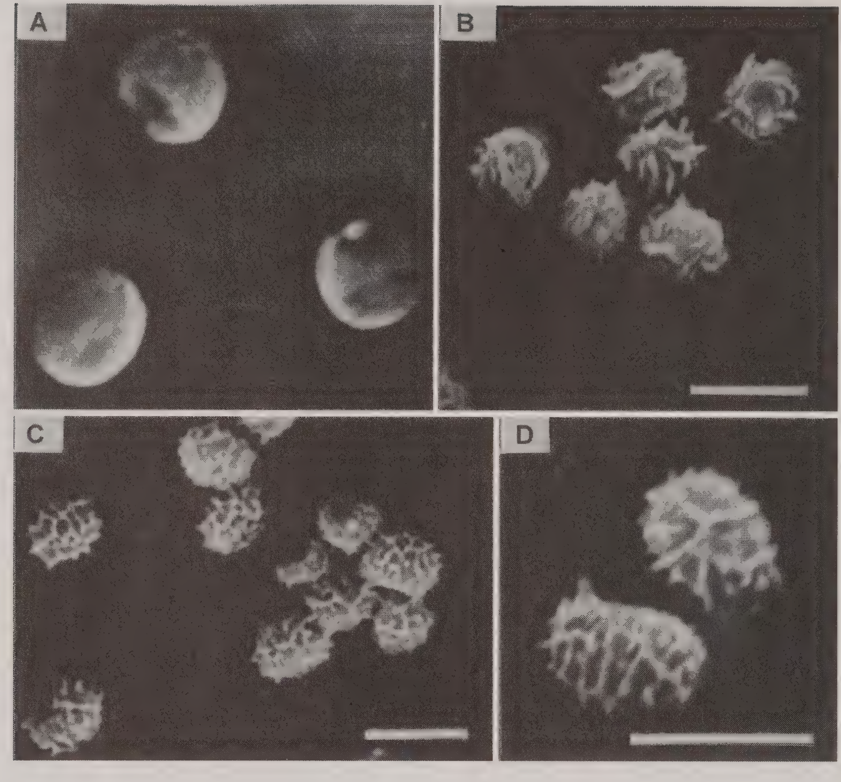

Fig. 4 Spores under SEM. A, *Lactarius dwaliensis* (bar = 10 µm). B, *Lactarius maitlyensis* (bar = 10 µm). C & D, *Lactarius dafianus* (bar = 10 µm).

Pileus 65-75 mm diam., convex, applanate with depressed center when mature; pileipellis slightly moist, medium to dark reddish orange becoming deep reddish purple or blackish at center, zonate; zones more distinct towards periphery. *Lamellae* rather dense (*ca* 5 per cm), emarginate to subdecurrent, forked, lamellulae in several rows, light yellowish pink. *Stipe* 25-32 x 8-11 mm, cylindric, slightly tapering towards base, medium reddish to rusty brown; context hollow, pale to pale orange yellow. *Latex* watery white, unchanging. Spore print white.

Spores 7.7-9.5 x 5.9-6.7 µm (*n* = 20, Q = 1.20-1.42), broadly ellipsoid to ellipsoid; ornamentation amyloid, up to 1 µm high, composed of rather spiny warts and ridges, often aligned or connected, never forming a complete reticulum, at most a very incomplete reticulate pattern, but isolated warts and ridges mostly quite abundant; plage not or very slightly distally amyloid. *Basidia* 35-45 x 10-12 µm, subcylindric to subclavate, 4-spored. *Pleuromacrocystidia* 55-84 x 6-11 µm, abundant, fusiform with mucronate to moniliform apices, with needle-like contents, originating rather deep in the hymenium. Lamellae edge with scattered basidia and cheilomacrocystidia. *Cheilomacrocystidia* 54-70 x 5-10 µm, lanceolate to fusiform, contents as in pleuromacrocystidia. Hymenophoral trama composed of hyphae and abundant sphaerocytes, lactifers up to 8 µm broad. *Pileipellis* a loosely interwoven trichoderm, up to 80 µm thick; terminal elements 30-60 x 3-6 µm, cylindric.

Additional specimens examined: India: Uttaranchal, Pithoragarh, Kannar, 2000 m, on ground, ectomycorrhizally associated with *Rhododendron arboreum* Sm., 4th Oct. 2001, *K. Das & J.R. Sharma*, KD4088 (BSD).

Lactarius dafianus grows gregariously in close association with *Rhododendron arboreum* in temperate deciduous Himalayan forests (2000-2500 m).

The dry pileus, unchanging latex, non-scrobiculate stipe, trichoderm pattern of pileipellis and incomplete reticulate arrangement of warts and ridges on spores place this species under the subgenus *Piperites* (Fr.) Kauffman, section *Colorati* (Bat.) Hesler & A.H. Sm.

Lactarius dafianus resembles *L. rufus* (Scop.: Fr.) Fr., but the latter differs by the azonate pileus with a distinct umbo. Furthermore, in *L. rufus*, spore print is "cream buff to pale pinkish buff" in color and spores are larger (8.5-10.5 (12) x 6-7.5 (-8) µm) (Hesler & Smith 1979).

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REFERENCES

Abraham, S.P. & Kaul, T.N. (1985) Larger fungi from Kashmir III. *Kavaka* **12**(2): 77-81.

Atri, N.S. & Saini, S.S. (1986) Further contributions on the studies of North-West Himalayan Russulaceae. *Geobios New Rep.* **5** (2): 100-105.

Atri, N.S., Saini, M.K. & Saini, S.S. (1994) Indian Russulaceae Roze – A Check List, In: T.A. Sharma, S.S. Saini, M.L. Trivedi & M.Sharma (eds.). 81-93. *Current Researches in Plant Sciences*, Dehradun.

Atri, N.S., Saini, S.S., Saini, M.K. & Gupta, A.K. (1993) Systematic studies of Russulaceous fungi - The Genus *Lactarius*. *J. Indian Bot. Soc.* **72**: 155-158.

Bhatt, R.P. & Lakhanpal, T.N. (1990) Fleshy fungi of North-western Himalayas-V: *Indian Phytopath.* **43** (2): 156-164.

Bhatt, V.K., Bhatt, R.P. & Gaur, R.D. (1999) Study on the section *Lactifluus*, of the genus *Lactarius* in India. *Indian Phytopath.* **52** (3): 236-244.

Bhatt, V.K., Bhatt, R.P. & Gour R.D. (2000) Mushrooms of the Garhwal Himalaya: the genus *Lactarius* Pers. *ex* SF Gray. *Mush. Res.* **9** (1): 11-18.

Das, K. & Sharma, J.R. (2002) The genus *Lactarius* in India. *Bull. Bot. Surv. Ind.* (in press).

Heilmann-Clausen, J., Verbeken, A. & Vesterholt, J. (1998) *The genus Lactarius*. The Danish Mycological Society. 287 pp.

Hesler, L.R. and Smith, A.H. (1979) *North American Species of Lactarius*. Univ. Michigan, Ann Arbor. 841 p.

Holmgren, P.K., Holmgren, N.H. & Barnett, L.C. (1990) *Index Herbariorum*. Part 1: Herbaria of the world, 86th ed. Brox: New York Botanical Garden.

Kelly, K.L. & Judd, D.B. (1955) *The ISCC-NBS Method of Designating Colours and A Dictionary of Colour Names, NBS Circular 553*.

Montoya, L. & Bandala, V.M. (2003) Studies on *Lactarius*: a new combination and two new species from Mexico. *Mycotaxon* **85**: 393-407.

Rawla, G.S. (2002) *Lactarius* D.C. *ex* S.F. Gray in India - List and critical review. In: T. Pullaiah (ed.) *Biodiversity in India* vol. 1. 221-255. New Delhi.

Saini, S.S. & Atri, N.S. (1982) North Indian Agaricales-III. *Soc. Indian natn. Sci. Acad.* **48** (3): 453-457.

Watling, R. & Gregory, N.M. (1980) Larger fungi from Kashmir. *Nova Hedwigia* **32**: 493-547.

MYCOTAXON

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NEW SPECIES AND NEW RECORDS OF BIONECTRIACEAE AND NECTRIACEAE (HYPOCREALES) FROM CHINA

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Abstract: A new species, *Nectriopsis hainanensis* of the Bionectriaceae, an unnamed species of *Lanatonectria* and a new Chinese record, both of the Nectriaceae, are described and illustrated.

Key words: *Nectriopsis hainanensis*, *Lanatonectria* taxonomic sp., *Haematonectria illudens*

Fifty-five species of the Bionectriaceae and Nectriaceae have been recorded from China (Teng 1963; Zhuang & Zhang 2002; Zhang & Zhuang 2003, 2004). Most of them occur on recently dead wood or bark of dicotyledons, such as *Bionectria byssicola* (Berk. & Broome) Schroers & Samuels, *B. ochroleuca* (Schwein.) Schroers & Samuels, *Nectria cinnabarina* (Tode : Fr.) Fr., *Neonectria coronata* (Penz. & Sacc.) Mantiri & Samuels, etc., or on fallen leaves like *Bionectria tornata* (Höhn.) Schroers, *Calonectria* cf. *pyrochroa* (Desm.) Sacc., and *Cosmospora chaetopsinae* (Samuels) Rossman & Samuels. Others are on monocotyledons, for example, *Nectriopsis mindoensis* (Petr.) Samuels and *Gibberella bambusae* (Teng) W.Y. Zhuang & X.M. Zhang on bamboo culms, and *G. zeae* on ears of wheat. Still other species are found on other fungi, like *Cosmospora nummulariae* (Teng) W.Y. Zhuang & X.M. Zhang on *Biscogniauxia* sp. (= *Nummularia* sp.), *C. purtonii* (Grev.) Rossman & Samuels on an effete carbonaceous pyrenomycete, *Nectriopsis uredinophilia* (Syd.) W.Y. Zhuang & X.M. Zhang, and *N. epinectria* (Teng) Samuels. Thirty species are currently known from Hainan Province; *Bionectria byssicola, B. ochroleuca, Haematonectria haematococca* (Berk. & Broome) Samuels & Nirenberg, and *Lanatonectria flocculenta* (Henn. & E. Nyman) Samuels & Rossman are common species there. Compared with the Hainan fungal flora recorded in the 1930's, *Nectria sinensis* is no longer common, with only one specimen collected in our 2000 field work. *Nectria lateritia* seems to be rarely found due to changes in environmental conditions. Three species from Hainan Province are newly discovered, including a new species of *Nectriopsis* Maire, an unnamed species of *Lanatonectria* Samuels & Rossman, and a new Chinese record. The taxonomic treatments by Rossman *et al.* (1999) are adopted and their methods are followed.

Nectriopsis hainanensis X.M. Zhang & W.Y. Zhuang, sp. nov. 海南拟赤壳 Figs. 1-2

Ab *Nectripside lasiodermiopside* differt perithecia non-papilatis, globosis vel subglobosis, 183-273 μm diam.; ascis 4-8-sporis, longis, (50-) 60-66 (-71) x (4.2-) 5.5-6.5 (-7) μm; ascosporis uniseptatis, 9.6-12.8 x 2.7-3.5 μm.

Perithecia solitary to gregarious (up to 4 in a group), seated on a thin layer of stroma and difficult to remove from the substrate, globose to subglobose, wall smooth, nonpapillate, usually becoming cupulate when dry, pale orange-yellow, semi-translucent, neither changing color in 3% KOH aqueous solution nor in lactic acid, 183-273 μm in diam. Ostiole up to 63 μm in wide; perithecia wall of two layers 27-32 μm thick, outer layer ca. 25 μm thick, of unevenly thickened walled cells (walls 2-3 μm thick), cells lumina 4-8.6 μm in diam., inner layer ca. 7.5 μm thick, cells angular to elongate, thin-walled, 3-6 μm in diam. if globose; Asci narrowly clavate to subcylindrical, with an apical ring, 4-8 spored, (50-)60-66(-71) x (4.2-)5.5-6.5 (-7) μm; ascospores uniseriate, ellipsoid to fusoid, equally 2-celled, not constricted at the septum, hyaline, with 2-4 guttles in each spore, spinulose, 9.6-12.8 x 2.7-3.5 μm.

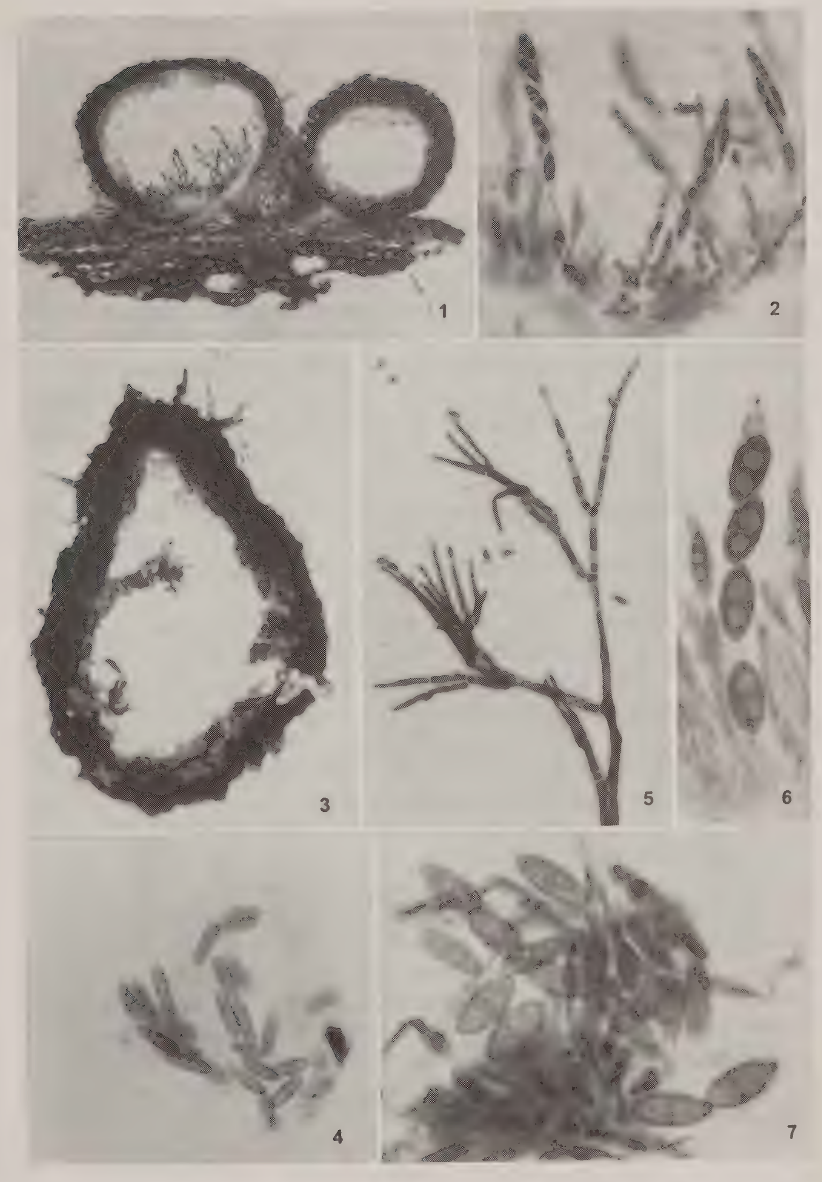
Anamorph: *Acremonium* sp.

Holotype: China. Hainan: Jianfengling, Ledong County, alt. 1100 m, on bark, 9 XII 2000, W.Y. Zhuang and X.M. Zhang H48, HMAS 83333.

Notes: The perithecial color, size, non-reaction to 3% KOH aqueous solution or lactic acid, presence of an apical ring at ascus apex, and the *Acremonium* anamorph of the fungus indicate that it is a member of *Nectriopsis* Maire. Among species of *Nectriopsis*, *N. lasiodermopsis* Samuels is the most similar to *N. hainanensis* in its ascospore size and anamorph, but the perithecia of the former are pyriform, with a short papilla, with hairs protruding from the papilla, and collapsing laterally when dry. The perithecial wall of *N. lasiodermopsis* is thinner [ca. 15 μm thick] and asci are shorter [(35-) 37-45 (-48) x (7-) 9-10 μm] (Samuels, 1988). We treat the above distinctions at species level.

***Lanatonectria* taxonomic sp.** 弯毛壳属一未定名种 Figs. 3-5

Stroma absent. Perithecia solitary, seated on a thin layer of hyphae and easy to remove from the substrate, broadly ovoid, with an acute papilla, not collapsing when dry, walls smooth, with sparse hairs, orange red to dark red, becoming darker in KOH and light orange in lactic acid, 218-240 μm high, 178-202 μm wide. Papilla ca. 32 μm high, 21 μm wide. Hairs straight, protruding around the ostiolar region, subcylindrical, tapering toward the apex, 2-5 septate, hyaline, smooth-walled, 51-100 μm long, 5.5-7.5 μm wide. Perithecial wall of one layer, 21-30 μm thick, cells angular, lumina 6.4-17 x 3.2-6 μm, wall 1.5-3.2 μm thick. Asci clavate, with an apical ring, 8-spored, 39-43 x 6.4-7 μm. Ascospores elongate ellipsoid, 1-septate, not constricted at the septum, hyaline, spinulose, forming faint striations on surface, biseriate, 9.6-12 x 2.8-3.5(-4.5) μm.



Figs. 1-2. *Nectriopsis hainanensis* (HMAS 83333): 1. Median section of ascomata, x 115; 2. Asci with ascospores, x 565. Figs. 3-5. *Lanatonectria* taxonomic sp. (HMAS 83378): 3. Median section of an ascoma showing hairs around the ostiolar region, x 225; 4. Ascospores, x 565; 5. Conidiophore and conidia, x 565. Figs. 6-7. *Haematonectria illudens* (HMAS 83349): 6. Asci with ascospores, x 565; 7. Ascospores showing striations on surface, x 565.

Anamorph (H113-1): Colonies reaching 22-25 mm diam 7 days at 25°C on PDA, margin entire, aerial mycelium abundant, reverse pale yellow. Red pyriform perithecia formed in culture, aggregated, with straight hairs on the surface. Conidiophores arising from aerial hyphae, not branching or with 2-3 branches, 38-128 x 2-2.5 µm. Conidiogenous cells phialidic, subcylindrical, 28-82 x 1.5-2 µm. Conidial mass globose, white, slimy, 26-47 µm in diam., conidia two celled, ovoid to subcylindrical, (5-) 6.5-11 x 2.5-3.5 µm.

Specimen examined: China, Hainan, Limushan, Qiongzhong county, alt. 700m, on bark, 18 XII 2000, W.Y. Zhuang & X.M. Zhang H113-1, HMAS 83378.

Notes: The species is associated with *Lanatonectria flocculenta* (HMAS 76873) on the same substrate. Among species of *Lanatonectria, L. raripila* (Penz. & Sacc.) Samuels & Rossman (Rossman *et al*., 1999) also has smooth-walled hairs, but its ascospores are fusiform, and larger [(24-) 27.5-32 (-33) x (6-) 6.5-8 µm *vs*. 9.6-12 x 2.8-3.5 µm]. HMAS 83378 represents an undescribed taxon of *Lanatonectria*. Because of the material is too scanty to be a type, it is treated tentatively as *Lanatonectria* taxonomic sp.

Haematonectria illudens (Berk.) Samuels & Nirenberg, Stud. Mycol. 42: 136, 1999.
梭孢血赤壳 Figs. 6-7

≡ *Nectria illudens* Berk. in Hooker, The Botany of the Antarctic Voyage. II. Flora of New Zealand part 7. Nat. Order C II, p. 203, 1855.

Specimens examined: China. Hainan: Bawangling, Changjiang County, alt. 1100 m, 7 XII 2000, on bark, W.Y. Zhuang, X.M. Zhang & Z.H. Yu H22, 25, 28, 30, HMAS 76854, 83349, 76865, 83369; on bark, Jianfengling, Ledong County, alt. 1100 m, 9 XII 2000, W.Y. Zhuang, X.M. Zhang & Z.H. Yu H36, 41, HMAS 83350, 83370; on bark, Diaoluoshan, Lingshui County, alt. 1100 m, 13 XII 2000, W.Y. Zhuang & X.M. Zhang H70, HMAS 76866; on bark, Wuzhishan, Tongshi County, alt. 1000 m, 16 XII 2000, W.Y. Zhuang, X.M. Zhang, Z.H. Yu & Y.H. Zhang H105, HMAS 83371; on bark, Limushan, Qiongzhong County, alt. 700 m, 18 XII 2000, W.Y. Zhuang & X.M. Zhang H124, HMAS 76867.

Notes: This fungus is common in Hainan. The perithecia are erumpent through the bark, with a basal stroma, solitary to gregarious (up to 50), globose to pyriform with a small papilla, orange yellow to red, with large concolorous warts. Warts are up to 25-80 µm high and composed of globose, thick-walled cells. The perithecial walls are 36-64 µm thick (excluding the warts). Compared with the descriptions of *H. illudens* by Booth (1971) and Rossman *et al.* (1999), the materials from China have smaller perithecia [319-553 x 221-340 µm *vs.* (345-) 400-600 (-700) x (280-) 357-584 (-700) µm], smaller asci [60-96 (-123) x 7.5-12 µm *vs.* (100-) 120-160 (-180) x 12-17 µm], and mostly 4-spored asci.

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REFERENCES

Booth, C. (1971) The Genus *Fusarium*. Commonwealth Mycological Institute, Kew. pp. 1-237.

Rossman, A.Y., G.J. Samuels, C.T. Rogerson & R. Lowen (1999) Genera of Bionectriaceae, Hypocreaceae and Nectriaceae (Hypocreales, Ascomycetes). *Stud. Mycol*. 42: 1-260.

Samuels, G.J. (1988) Fungicolous, lichenicolous, and myxomyceticolous species of *Hypocreopsis*, *Nectriopsis, Nectria, Peristomialis*, and *Trichonectria*. *Mem. New York Bot. Gard*. 48: 1-78.

Teng, S.C. (1963) Fungi of China. Science Press, Beijing. (in Chinese)

Zhang, X.M. & W.Y. Zhuang (2003) Re-examinations of Bionectriaceae and Nectriaceae (Hypocreales) from temperate China on deposit in HMAS. *Nova Hedwigia* 76: 191-200.

Zhang, X.M. & W.Y. Zhuang (2004) New Chinese records of the Bionectriaceae and Nectriaceae. *Mycosystema* 23(1). (accepted)

Zhuang, W.Y. & X.M. Zhang (2003) Re-examinations of Bionectriaceae and Nectriaceae (Hypocreales) from tropical China on deposit in HMAS. *Nova Hedwigia* 74: 275-283.

MYCOTAXON

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MACROFUNGUS FLORA OF THE LAGOON OF VENICE AND ADJACENT AREAS (ITALY). NON-GILLED BASIDIOMYCETES. III. POLYPOROID, HYDNOID, CLAVARIOID APHYLLOPHORALES AND HETEROBASIDIOMYCETES.

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ABSTRACT: 86 species of Aphyllophorales and 31 species of Heterobasidiomycetes arranged in 39 and 15 genera respectively for a total of 919 records are reported from the Lagoon of Venice and adjacent areas. More interesting or deviating specimens are briefly described or commented on.

KEYWORDS: non-corticioid aphyllophoroid fungi, heterobasidiomycetous fungi, northern Italy

INTRODUCTION: This is the third paper in a series on Basidiomycetes without gills of the Venetian Lagoon and adjacent areas. The two previous reports dealt with tomentelloid (Losi, 1977) and corticioid (Losi, 1999) fungi; the reader is referred to these papers for the characteristics of the area concerned. The number of records is given in brackets after the reference to the locality. The specimens are deposited in the author's private herbarium and /or in MCVE.

List of the localities the position of which can be found on the map. (Fig. 1).

01 Asseggiano Wood
02 Carpenedo Wood
03 Ca'Noghera Wood
04 Mestre (public parks and gardens)
05 Valle Averto a wetland
06 Reclaimed land Cassa colmata B
07 Certosa Island.
08 Caroman Wood
09 Alberoni Wood
10 S. Nicolò Wood
11 Ca'Savio Wood.
12 Venice (public parks and gardens)
13 Carbonera Island
14 Madonna del Monte Island
15 S. Giacomo in Palude Island.
16 Lazzaretto Nuovo Island.
17 S. Francesco del Deserto Island
18 S. Cristina Island
19 Ossario di S. Ariano Island
24 S. Clemente Island
25 Sacca Sessola Island
26 S. Angelo della Polvere Island.
27 ex Poveglia Island
28 Campana Island

20 ex Salina Island
21 Caposile
22 Reclaimed land Cassa colmata A.
23 S. Giorgio in Alga Island
29 S. Lazzaro Island
30 Lazzaretto Vecchio Island
31 Lido (public parks and gardens)

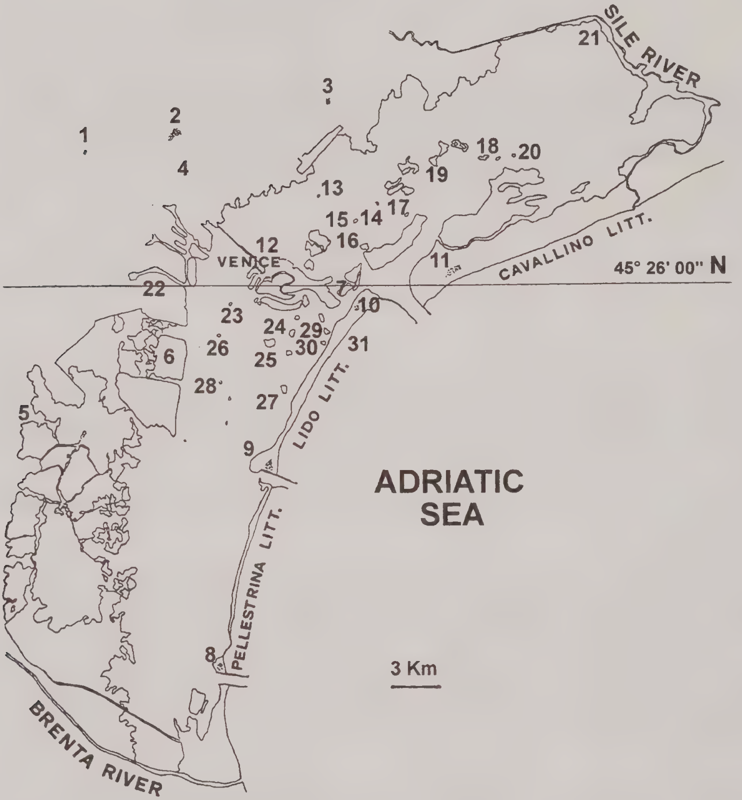
SILE RIVER
21
3
2
1
4
18
20
19
13
17
15
14
16
12
VENICE
11
CAVALLINO LITT.
45° 26' 00" N
22
7
10
23
24
29
26
6
25
30
31
28
27
5
LIDO LITT.
9
ADRIATIC SEA
PELLESTRINA LITT.
8
3 Km
BRENTA RIVER

Fig. 1. Map of the localities.

POLYPOROID APHYLLOPHORALES

Abortiporus biennis (Bull.) Singer
HABITAT: on hardwoods. DISTRIBUTION: 1 (1), 2 (5), 4 (7), 25 (1).

Antrodia malicola (Berk. & M.A. Curtis) Donk
HABITAT: on unidentified hardwood. DISTRIBUTION: 7 (1).

Antrodia xantha (Fr.) Ryvarden
HABITAT: on structural wood. DISTRIBUTION: 15 (1), 21 (1).

Antrodiella onychoides (Egeland) Niemelä
HABITAT: on *Robinia*. DISTRIBUTION: 3 (1), 15 (1).

Antrodiella romellii (Donk) Niemelä

HABITAT: on deciduous wood. DISTRIBUTION: 4 (2).

Bjerkandera adusta (Willd.) P. Karst.

HABITAT: on deciduous wood. DISTRIBUTION: 1 (5), 2 (8), 3 (1), 4 (10), 5 (2), 8 (5), 10 (1), 11 (8), 12 (1), 13 (1), 14 (1), 15 (2), 17 (2), 25 (1), 31 (1).

Bjerkandera fumosa (Pers.) P. Karst.

HABITAT: associated with angiosperms. DISTRIBUTION: 2 (1), 3 (1), 4 (2), 9 (1), 12 (1).

Ceriporia camaresiana (Bourdot & Galzin) Bondartsev & Singer.

Basidiome resupinate, soft,up to 2 mm thick. Pore surface whitish to cream, mostly cinnamon on drying; pores 3-5 per mm, regular, rarely slightly labyrinthine. Margin thin, white, arachnoid to fimbriate; subiculum very thin. Hyphal system monomitic: generative hyphae simple-septate, up to 6.4 μm wide, thin- to slightly thick-walled, often encrusted. Cystidia absent. Basidia clavate, 4-sterigmate, 12.8-18 x 5.2-6.4 μm. Basidiospores bean shaped, (4-) 4.4-6.8 x (2.2-) 2.4-2.8 (-3,2) μm. Five specimens, from two localities, kept a light colour even on drying. Rhizomorphs present in one specimen.

HABITAT: usually on hardwoods such as *Populus*, *Elaeagnus*, *Robinia* and *Tamarix*, once also found on *Pinus*. DISTRIBUTION: 5 (1), 6 (2), 8 (8), 9 (5), 11 (1), 13 (2).

Ceriporia purpurea (Fr.) Donk.

Coll. Losi 1097 is macroscopically typically dried specimen with a dark purplish colour (Vampola & Pouzar, 1996) and has basidiospores allantoid, 5.6-6.4 x 1.6-2 μm. Coll. Losi 1805 and 1885 have a lighter dried pore surface, even though the size of allantoid basidiospores is 6.4-8.2 x 1.8-2.6 μm. According to Lowe (1966) both collections fit well in *C. purpurea*.

HABITAT: on deciduous wood. DISTRIBUTION: 11 (2), 15 (1).

Ceriporia reticulata (Hoffm.) Domanski.

Basidiospores 6.8-7.6 x 2.6-3.3 μm.

HABITAT: on *Alnus*. DISTRIBUTION: 11 (1).

Ceriporia viridans (Berk. & Broome) Donk.

Basidiome resupinate, soft, 1-2 mm thick. Colour of pore surface variable: white, cream, yellowish, reddish, pinkish or dull orange, rarely with greenish tint; when dried, cinnamon to muted pinkish. Pores 4-6 per mm, regular. Margin narrow, thin, white, arachnoid to fimbriate. Subiculum very thin, sometimes apparently absent. Hyphal system monomitic: generative hyphae with simple septa, up to 10 μm wide, thin- to slightly thick-walled, encrusting material often present. Cystidia absent. Basidia clavate, 4-sterigmate, 10.4-14 x 4.4-5.4 μm. Basidiospores suballantoid, 3.2-5 x 1.2-1.8 (-2) μm.

HABITAT: on hardwoods, especially *Alnus*. DISTRIBUTION: 7 (2), 8 (2), 10 (1), 11 (2).

Ceriporiopsis gilvescens (Bres.) Domanski

Basidiospores 3.8-4,8 x 1,6-2,2 (2.5) μm.

HABITAT: on *Carpinus*. DISTRIBUTION: 1 (1), 2 (1).

Coltricia perennis (Fr.) Murrill

HABITAT: in vicinity of a fireplace. DISTRIBUTION: 7 (1).

Coriolopsis gallica (Fr.) Ryvarden

HABITAT: on *Quercus*. DISTRIBUTION: 2 (1).

Coriolopsis trogii (Berk.) Domanski

HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 4 (1), 7 (2), 8 (2), 9 (4), 10 (1), 11 (4), 15 (1), 16 (2), 17 (1), 25 (1).

Daedaleopsis confragosa (Bolton) J. Schröt.

HABITAT: on *Salix alba* and S. *matsudana cv. tortuosa*. DISTRIBUTION: 4 (1), 6 (1).

Datronia mollis (Sommerf.) Donk

HABITAT: on deciduous wood. DISTRIBUTION: 2 (1).

Fistulina hepatica (Schaeff.) With.

HABITAT: on *Quercus*. DISTRIBUTION: 1 (2), 2 (2).

Fomes fomentarius (L.: Fr.) Kickx

HABITAT: on deciduous wood. DISTRIBUTION: 2 (3), 8 (1), 9 (1), 12 (3), 31 (1).

Fomitopsis iberica Melo & Ryvarden

HABITAT: on *Pinus*. DISTRIBUTION: 8 (1).

Ganoderma adspersum (Schulzer) Donk

HABITAT: on hardwoods. DISTRIBUTION: 1 (3), 2 (5), 4 (10), 7 (2), 9 (1), 10 (1), 11 (3), 12 (2), 13 (1), 17 (1), 24 (1), 25 (2), 29 (1).

Ganoderma lucidum (Curtis) P. Karst.

HABITAT: on hardwoods. DISTRIBUTION: 1 (5), 2 (5), 3 (1), 5 (1), 12 (2), 25 (2), 29 (1), 31 (1).

Ganoderma resinaceum Boud.

HABITAT: on hardwoods. DISTRIBUTION: 4 (5), 9 (1), 11 (2), 12 (1), 31 (2).

Gloeophyllum abietinum (Bull.) P. Karst.

HABITAT: on *Pinus*. DISTRIBUTION: 4 (1), 5 (1), 9 (1).

Gloeophyllum sepiarium (Wulfen) P. Karst.

HABITAT: on *Pinus* and structural wood. DISTRIBUTION: 8 (2), 9 (1), 12 (1), 15 (1).

Gloeophyllum trabeum (Pers.) Murrill

HABITAT: on *Pinus* and structural wood. DISTRIBUTION: 4 (2),7 (1), 8 (6), 9 (2), 11 (2), 15 (1).

Hapalopilus nidulans (Fr.) P. Karst.

HABITAT: on unidentified deciduous wood. DISTRIBUTION: 3 (1).

Heterobasidion annosum (Fr.) Bref.

HABITAT: on *Pinus*. DISTRIBUTION: 9 (3), 11 (4).

Inonotus dryadeus (Pers.) Murrill

HABITAT: on *Quercus*. DISTRIBUTION: 2 (3).

Inonotus hispidus (Bull.) P. Karst.

HABITAT: on *Morus*, *Platanus* and *Sophora*. DISTRIBUTION: 5 (1), 12 (2).

Inonotus tamaricis (Pat.) Maire

HABITAT: on *Tamarix*. DISTRIBUTION: 4 (2), 5 (3), 8 (4), 9 (1), 12 (1), 13 (5), 17 (2), 21 (1), 31 (1).

Laetiporus sulphureus (Bull.) Murrill

HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 4 (1).

Lenzites betulinus (L. : Fr.) Fr.

HABITAT: on deciduous trees. DISTRIBUTION: 1 (2), 5 (2), 11 (2).

Lenzites warnieri Durieu & Mont.

HABITAT: on *Populus*. DISTRIBUTION: 9 (1).

Meripilus giganteus (Pers.) P. Karst.

HABITAT: on *Carpinus*. DISTRIBUTION: 4 (1).

Oligoporus balsameus (Peck) Gilb.& Ryvarden

Basidiospores 3,8-4.4 x 2.4-2.6 µm.

HABITAT: on *Taxus* and *Cedrus*. DISTRIBUTION: 2 (1), 4 (1).

Oligoporus caesius (Schrad.) Gilb.& Ryvarden

Basidiospores 1.4-2 µm wide.

HABITAT: on *Pinus*. DISTRIBUTION: 8 (2), 9 (1), 11 (2).

Oligoporus hibernicus (Berk. & Broome) Gilb. & Ryvarden

In coll. Losi 2042 pore surface white, cream on drying, pores circular to angular, 3-5 per mm; basidiospores allantoid to suballantoid, 3.4-4.4 x 0.9-1.6 µm. In coll. Losi 2041 pore surface ochre when dry, with 1-3 per mm irregular pores, basidiospores suballantoid, 4.4-5.4 x 1.4-1.6 µm. Both with rare, smooth or capitately encrusted hyphoid cystidia.

HABITAT: on *Pinus*. DISTRIBUTION: 8 (2).

Oligoporus leucomallellus (Murrill) Gilb. & Ryvarden

HABITAT: on *Pinus*. DISTRIBUTION: 8 (3), 11 (1).

Oligoporus rennyi (Berk.& Broome) Donk

Basidiospores narrowly ellipsoid to subcylindrical, slightly thick-walled, 4-6,5 x 2,4-3,2 µm.

HABITAT: on *Pinus*. DISTRIBUTION: 2 (1), 8 (7), 11 (3).

Oligoporus stypticus (Pers.) Gilb. & Ryvarden

HABITAT: on *Pinus*. DISTRIBUTION: 8 (5), 9 (1).

Oligoporus subcaesius (David) Ryvarden & Gilb.

Upper surface of dried specimens whitish to ochraceous, grayish tints sometimes present on pore surface; basidiospores suballantoid, 4-5.4 x 1-1.6 µm.

HABITAT: on hardwoods. DISTRIBUTION: 8 (2), 9 (4), 11 (2), 15 (1), 30 (1).

Oxyporus latemarginatus (E.J. Durand & Mont.) Donk

HABITAT: on hardwoods, rarely on *Pinus*. DISTRIBUTION: 1 (3), 2 (2), 4 (3), 5 (3), 7 (3), 8 (2), 10 (1), 11 (1), 15 (3), 16 (1), 25 (2).

Oxyporus obducens (Pers.) Donk

Basidiome resupinate except one pileate specimen on living Hippocastaneus.

HABITAT: on hardwoods. DISTRIBUTION: 4 (1), 9 (1), 10 (1), 12 (1).

Parmastomyces transmutans (Overh.) Ryvarden & Gilb.

HABITAT: on *Pinus*. DISTRIBUTION: 8 (3).

Perenniporia fraxinea (Bull.) Ryvarden

HABITAT: on hardwoods, especially *Robinia*. DISTRIBUTION: 1 (1), 2 (1), 4 (10), 10 (1), 11 (1), 24 (1), 25 (1), 31 (2).

Perenniporia ochroleuca (Berk.) Ryvarden

HABITAT: on *Prunus avium*. DISTRIBUTION: 16 (2).

Phaeolus schweinitzii (Fr.) Pat.

HABITAT: on *Cedrus*. DISTRIBUTION: 4 (1).

Phellinus ferruginosus (Schrad.) Bourdot & Galzin

HABITAT: on hardwoods. DISTRIBUTION: 1 (1), 2 (5), 3 (1), 4 (1), 6 (2), 8 (3), 11 (7), 13 (2), 15 (2), 26 (1), 28 (1).

Phellinus igniarius (Fr.) Quél.

HABITAT: on *Robinia*. DISTRIBUTION: 21 (1).

Phellinus pomaceus (Pers.) Maire

HABITAT : on *Prunus*. DISTRIBUTION: 4 (2).

Phellinus punctatus (P. Karst.) Pilát

HABITAT: on hardwoods. DISTRIBUTION: 1 (3), 4 (8), 5 (2), 6 (2), 8 (10), 9 (7), 11 (4), 12 (3), 13 (1), 15 (1), 16 (2), 23 (2), 25 (2).

Phellinus rimosus (Berk.) Pilát

HABITAT: on *Robinia*. DISTRIBUTION: 31 (1).

Phellinus torulosus (Pers.) Bourdot & Galzin

HABITAT: on *Robinia*. DISTRIBUTION: 4 (2).

Physisporinus vitreus (Pers.) P. Karst.

HABITAT: on structural wood. DISTRIBUTION: 8 (2).

Phylloporia ribis (Schumach.) Ryvarden

HABITAT: on *Robinia*. DISTRIBUTION: 4 (1).

Polyporus alveolaris (DC.) Bondartsev & Singer

HABITAT: on hardwoods. DISTRIBUTION: 4 (2), 11 (1).

Polyporus arcularius Batsh : Fr.

HABITAT: on dead branches of *Alnus*. DISTRIBUTION: 11 (1).

Polyporus badius (Pers.) Schwein.

HABITAT: on *Salix* and *Robinia*. DISTRIBUTION: 2 (1), 5 (1).

Polyporus squamosus Huds.: Fr.

HABITAT: on hardwoods. DISTRIBUTION: 2 (7), 4 (12), 8 (1), 11 (3), 12 (1), 32 (1).

Rigidoporus ulmarius (Sowerby) Imazeki

HABITAT: on *Platanus* and *Populus*. DISTRIBUTION: 12 (2), 31 (1).

Schizopora flavipora (Cooke) Ryvarden

Basidiospores 3.4-4.8 x 3-3.8 µm. Thin- to slightly thick-walled, heavily apically encrusted hyphoid cystidia present in some specimens. However, these seem not to be *S. cystidiata* as indicated by Ryvarden & Gilbertson (1994); also spores size could be important in this respect (Langer, 1994).

HABITAT: on hardwoods and *Pinus*. DISTRIBUTION: 1 (5), 2 (4), 11 (1).

Schizopora paradoxa (Schrad.) Donk

HABITAT: on hardwoods. DISTRIBUTION: 3 (1), 4 (2), 5 (2).

Schizopora radula (Pers.) Hallenb.

HABITAT: on *Quercus* and *Alnus*. DISTRIBUTION: 1 (2), 2 (4), 11 (1).

Skeletocutis lenis (P. Karst.) Niemelä

HABITAT: on *Pinus*. DISTRIBUTION: 8 (1).

Trametes gibbosa (Pers.) Fr.

HABITAT: on various hardwoods. DISTRIBUTION: 1 (4), 2 (2), 4 (3), 5 (1), 7 (1), 8 (3), 10 (1), 11 (8), 12 (1).

Trametes hirsuta (Fr.) Pilát

HABITAT: on deciduous trees. DISTRIBUTION: 1 (2), 2 (4), 7 (1), 11 (4), 21 (1), 25 (1), 31 (1).

Trametes ochracea (Pers.) Gilb. & Ryvarden

HABITAT: on various hardwoods. DISTRIBUTION: 1 (1), 4 (1), 11 (1), 12 (1), 13 (2), 15 (1).

Trametes pubescens (Schumach.) Pilát

HABITAT: on *Populus*. DISTRIBUTION: 4 (1), 8 (1).

Trametes suaveolens L. : Fr.

HABITAT: on *Salix* and *Carpinus*. DISTRIBUTION: 2 (2), 4 (3).

Trametes versicolor (L. :Fr.) Pilát
HABITAT: on various hardwoods. DISTRIBUTION: 1 (4), 2 (10), 4 (6), 5(9), 7 (2), 8 (3), 9 (1), 11 (9), 12 (5), 13 (2), 16 (1), 25 (2), 27 (1), 30 (1).
Trichaptum abietinum (Dicks.) Ryvarden
HABITAT: on unidentified wood. DISTRIBUTION: 2 (1).
Trichaptum fuscoviolaceum (Ehrenb.) Ryvarden
HABITAT: on *Pinus*. DISTRIBUTION: 8 (1), 9 (1), 11 (2).
Tyromyces fissilis (Berk. & M.A. Curtis) Donk
HABITAT: on *Robinia*. DISTRIBUTION: 4 (1).

HYDNOID APHYLLOPHORALES

Auriscalpium vulgare Gray
HABITAT: on *P. pinaster* cones. DISTRIBUTION: 8 (1).
Hericium coralloides (Scop.) Pers.
HABITAT: on *Salix*. DISTRIBUTION: 4 (1).
Hydnellum ferrugineum (Fr.) P. Karst.
HABITAT : in mixed wood. Distribution: 2 (1).
Hydnum repandum L.: Fr.
HABITAT: in deciduous wood. DISTRIBUTION: 2 (6), 15 (1).
Hydnum rufescens Fr.
HABITAT: in deciduous wood. DISTRIBUTION: 2 (1).
Phellodon niger (Fr.) P. Karst.
HABITAT: in deciduous wood. DISTRIBUTION: 2 (1).

CLAVARIOID APHYLLOPHORALES

Clavaria argillacea Pers.
HABITAT: on sandy soil, among grass. DISTRIBUTION: 6 (1), 11 (1).
Clavulina cinerea (Bull.) J. Schröt.
HABITAT: on the ground, in deciduous wood.. DISTRIBUTION: 2 (1).
Clavulina coralloides (L. : Fr.) J. Schröt.
HABITAT : on the ground, in fields and woods. DISTRIBUTION: 1 (5), 2 (3), 4 (6), 9 (1), 10 (1), 11 (3), 17 (1).
Clavulina rugosa (Bull.) J. Schröt.
HABITAT: on the ground, under *Corylus avellana*. DISTRIBUTION: 5 (1).
Mucronella calva (Alb. & Schwein.) Fr.
HABITAT: on rotten wood. DISTRIBUTION: 2 (1), 4 (1), 7 (1), 8 (1), 11 (5), 13 (3), 25 (1).
Ramaria abietina (Pers.) Quél.
HABITAT: on *Pinus* debris. DISTRIBUTION: 8 (2), 9 (1), 11 (3), 17 (1).
Ramaria stricta (Pers.) Quél.
HABITAT: on rotten deciduous wood. DISTRIBUTION: 1 (1).
Typhula setipes (Grev.) Berthier
HABITAT: on *Populus alba* bark lying on soil and rotting leaves of *Populus nigra*. DISTRIBUTION: 8 (1), 25 (1).

HETEROBASIDIOMYCETES

ORDER AURICULARIALES

Auricularia auricula-judae (Bull.) J. Schröt.
HABITAT: on deciduous wood. DISTRIBUTION: 1 (4), 2 (7), 3 (2), 4(10), 5 (9), 6 (1), 7 (2), 8 (12), 9 (2), 10 (1), 11(6), 12(4), 13 (4), 15 (2), 20 (1), 23 (10), 24 (1), 25 (4), 26(2), 31 (1).
Auricularia mesenterica Pers.
HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 3 (1), 4 (1), 11 (2), 13 (2), 24 (1).

ORDER CERATOBASIDIALES

Thanatephorus cucumeris (A.B. Frank) Donk
HABITAT: on *Populus alba*. DISTRIBUTION: 8 (1)..
Thanatephorus fusisporus (J. Schröt.) Hauerslev & P. Roberts
HABITAT: on deciduous wood. DISTRIBUTION: 4 (2), 5 (2), 7 (1), 8 (1), 9 (1), 11 (1).

ORDER DACRYMYCETALES

Calocera cornea (Batsch) Fr.
HABITAT: on dead hardwood. DISTRIBUTION: 2 (1), 3 (1), 11 (1).
Calocera viscosa (Pers.) Fr.
HABITAT: on decayed wood. DISTRIBUTION: 2 (1).
Cerinomyces crustulinus (Bourdot & Galzin) G.W. Martin
Basidiome effused, ceraceous; hymenial surface smooth to colliculose, pale ochraceous with gray tinges; margin narrow and slightly fimbriate or not particularly differentiated. Basidiospores 8-10 x 3-4 μm.
HABITAT : on *Tamarix gallica*. DISTRIBUTION: 8 (1).
Dacrymyces capitatus Schwein.
HABITAT: on deciduous wood. DISTRIBUTION: 1 (1), 27 (1).
Dacrymyces lacrymalis (Pers.) Sommerf.
HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (1).
Dacrymyces stillatus Nees
HABITAT: on various hardwoods, Pinus and structural wood. DISTRIBUTION: 1 (3), 2 (6), 4 (3), 5 (1), 8 (7), 9 (3), 11 (7), 15 (3), 16 (1), 25 (3).

ORDER PLATYGLOEALES

Calacogloea peniophorae (Bourdot & Galzin) Oberw. & Bandoni
HABITAT: on *Hyphoderma praetermissum* and *Hyphodontia sambuci*. DISTRIBUTION: 2 (1), 7 (1), 8 (1).
Helicogloea farinacea (Höhn.) D.P. Rogers
HABITAT: on *Pinus*. DISTRIBUTION: 9 (1).
Helicogloea lagerheimii Pat.
HABITAT: on deciduous wood. DISTRIBUTION: 2 (1), 3 (1), 15 (1).

ORDER TREMELLALES

Basidiodendron caesiocinereum (Höhn. & Litsch.) Luck-Allen
HABITAT: on unidentified deciduous wood. DISTRIBUTION: 2 (1).

Basidiodendron eyrei (Wakef.) Luck-Allen
HABITAT: on *Alnus glutinosa*. DISTRIBUTION: 11 (1).
Bourdotia galzinii (Bres.) Trotter
HABITAT : on various hardwoods. DISTRIBUTION: 2 (5), 4 (1), 7 (1), 8 (1), 11(3), 25 (1).
Exidia glandulosa Fr.
HABITAT: on deciduous wood. DISTRIBUTION: 2 (3), 3 (1), 9 (1), 11 (3).
Exidiopsis effusa (Bref. ex Sacc.) A. Möller
Two fairly unusual specimens: coll. Losi 2338 with margin white, thinning out and fimbriate and coll. Losi 2339 with macroscopic features reminiscent of *E. laccata* (Bourdot & Galzin) Luck-Allen probably a synonym according to Roberts (1998); probasidia subglobose, an average 20 µm in diameter, basidiospores cylindrical-ellipsoid, 14.5-16.5 x 6.4-8.2 µm.
HABITAT: on decaying angiosperm wood. DISTRIBUTION: 4 (4), 6 (1), 7 (1), 8 (3), 9 (3), 11 (8), 13 (2), 25 (1).
Exidiopsis grisea (Pers.) Bourdot & L. Maire
HABITAT: on *Pinus*. DISTRIBUTION: 8 (1), 9 (1).
Myxarium grilletii (Bourdot) D.A. Reid
HABITAT: on *Populus nigra*. DISTRIBUTION: 8 (1).
Myxarium hyalinum (Pers.) Donk
HABITAT: on deciduous wood. DISTRIBUTION: 1 (4), 3 (1), 4 (2), 7 (2), 8 (5), 9 (1), 11 (4), 12 (1), 15 (5), 16 (1), 23 (1), 25 (1).
Sebacina incrustans (Pers.) Tul.
HABITAT: earth and vegetable remains. DISTRIBUTION: 1 (1), 4 (1), 10 (1).
Tremella foliacea Pers.
HABITAT: on old fence-post. DISTRIBUTION: 4 (1).
Tremella mesenterica Schaeff.: Fr.
HABITAT: on deciduous wood. DISTRIBUTION: 4 (1), 7 (2), 12 (1), 21 (1).
Tremella obscura (L.S. Olive) M.P. Christ.
HABITAT: on *Dacrymyces stillatus*. DISTRIBUTION: 9 (2)..
Tremella polyporina D.A. Reid
HABITAT: on *Oligoporus rennyi*. DISTRIBUTION: 8 (1).
Tremella virescens (Schumach.) Bref.
Basidiomes at first tuberculate, 2-3 mm wide and high, gregarious, then becoming confluent to cerebriform, gelatinous, greenish; drying brown to nearly black. Basidia globose to subglobose, 14-18 µm; basidiospores globose-subglobose, 6.5-9 µm in diam.; conidia subglobose 3.8-5 x 3-4 µm.
HABITAT: on deciduous wood. DISTRIBUTION: 4 (1).

ORDER TULASNELLALES

Tulasnella albida (Bourdot & Galzin)
Basidiospores 5-6.4 x 3.6-4.8 µm.
HABITAT: on *Sistotrema* sp., *Sistotrema brinkmannii* and *Physisporinus vitreus*. DISTRIBUTION: 8 (1), 10 (1), 11 (1).
Tulasnella pallida Bres.
HABITAT: on *Carpinus betulus*. DISTRIBUTION: 2 (1).
Tulasnella thelephorea (Juel) Juel
HABITAT: on *Botryobasidium* sp. DISTRIBUTION: 2 (1).

Tulasnella violea (Quél.) Bourdot & Galzin
Basidiospores 7-9.5 x 4.8-7.2 µm.
HABITAT: on *Alnus glutinosa, Oxyporus obducens* and *Ganoderma adspersum*. DISTRIBUTION: 4 (1), 9 (1), 11 (2).

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LITERATURE CITED

LANGER, E., 1994. Die Gattung Hyphodontia John Eriksson. Bibliotheca Mycologica. Band 154. J. Cramer, Berlin – Stuttgart.
LOSI, C., 1997. Macrofungus flora of the Lagoon of Venice and adjacent areas (Italy). Non-gilled Basidiomycetes. I. Tomentelloid fungi. Mycotaxon 64: 243-259.
LOSI, C., 1999. Macrofungus flora of the Lagoon of Venice and adjacent areas (Italy). Non-gilled Basidiomycetes. II. Corticioid fungi. Mycotaxon 71: 69-87.
LOWE, J.L., 1966. Polyporaceae of North America. The Genus Poria. State Univ. N.Y. Coll. For. Tech. Publ. 90: 1-183.
ROBERTS, P., 1998. A revision of the genera Heterochaetella, Myxarium, Protodontia, and Stypella (Heterobasidiomycetes). Mycotaxon 69: 209-248.
RYVARDEN, L. & GILBERTSON, R.L., 1994. European Polypores 2: 394-743. Fungiflora, Oslo.
VAMPOLA, P. & Z. POUZAR, 1996. Notes on some species of genera Ceriporia and Ceriporiopsis (Polyporaceae). Czech. Mycol. 48: 315-324.

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LIGNICOLOUS APHYLLOPHOROID BASIDIOMYCOTA IN AN ATLANTIC FOREST FRAGMENT IN THE SEMI-ARID CAATINGA REGION OF BRAZIL

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ABSTRACT

In this study of diversity of lignicolous aphyllophoroid Basidiomycota in an Atlantic Forest fragment in the semi-arid Caatinga region of the State of Bahia, Brazil, a total of 26 species were collected. Most of the taxa are pantropical, white-rot species, belonging to the polyporoid clade. *Pycnoporus sanguineus*, *Phellinus gilvus* and *Lentinus crinitus* were the most frequently collected taxa, both in number of specimens and in occurrence along the sampling period. Although surrounded by the semi-arid Caatinga vegetation and presumably isolated from the conventional Atlantic Forest region, the mycota of the submontane fragment seems to have no marked differences from the mycota of other fragments situated in the traditional domain of Atlantic Forest in lower altitudes.

KEY WORDS: tropical rain forest, steppic-savannah, basidiomycetes

INTRODUCTION

"Biodiversity hotspots" are areas with exceptional concentrations of endemic species, which are experiencing exceptional loss of habitat. Approximately 44% of all species of vascular plants and 35% of all species in four vertebrate groups are confined to 25 hotspots comprising only 1.4% of the land surface of the Earth. Some hotspots are much richer than others in terms of their numbers of endemics, such as Brazil's Atlantic Forest, which is considered the fourth "hottest" biodiversity hotspot of the Earth (Myers et al., 2000).

Taking into account only the vegetation criterium, 147 areas were designated for priority conservation in Brazil's Atlantic Forest, of which 79 were considered of exceptional biological importance (Fig. 1). Approximately 48% of those areas are in Northeastern States of Brazil, mainly in Bahia, Ceará, Alagoas and Pernambuco. Usually, those areas are relatively small, reflecting the existing fragmentation due to natural or anthropic causes. Some of those naturally fragmented areas are of considerable biogeographical interest, since they constitute humid submontane/montane forest fragments inside the semi-arid phytogeographic region of Caatinga (Steppic-Savannah), and may potentially harbour endemic and/or unknown biological species (Brasil, 2000).

As far as we know, there is only one study on species diversity of lignicolous Basidiomycota in Atlantic Forest fragments surrounded by Caatinga vegetation, which is a part of an unpublished post-doctoral work (Cavalcanti, 1976), encompassing some Atlantic Forest fragments in the State of Pernambuco.

The present work studied the diversity of lignicolous aphyllophoroid Basidiomycota in the northern part of "Serra da Jibóia", a natural forest fragmented area in the semi-arid Caatinga region of the State of Bahia, which is one of the 79 areas of exceptional biological importance in Brazil's

Atlantic Forest. The data was then compared to lignicolous aphyllophoroid basidiomycota inventories in other Atlantic Forest fragments.

MATERIAL AND METHODS

The area studied

"Serra da Jibóia" is a small group of hills, approximately 6 Km long, in the interplanaltic depressions of Paraguaçu River valley, around 100 km from the seaside, situated in the municipality of Santa Terezinha, in the central east of the State of Bahia, Brazil. "Serra da Jibóia" is covered by the semi-arid Caatinga vegetation in the base (the lower part), rocky fields in the upper part, and a submontane Atlantic forest in intermediate altitudes between 400-800m high. The mycota inventory was carried out in the submontane Atlantic forest fragment in "Morro da Pioneira", in the northern and highest part of "Serra da Jibóia" (12º 51' S e 39º 28' W) (Fig. 1).

Sampling and taxonomic work

Fieldwork was carried out along tracks, which cross the forest fragment in distinct parts. Collections were made during two years (November 1999 to February 2002), comprising all seasons. Macroscopic features were analyzed with the aid of a stereomicroscope, and freehanded sections were made for the study of microscopic characteristics. Slide preparations were stained with 1% phloxine, 5% KOH, and Melzer's reagent was used to test iodine reaction. All the specimens collected were primarily deposited in HUEFS. The general systematic arrangement followed Kirk et al. (2001). Although Hymenochaetales species were arranged in the traditional genera, since some species still deserve new combinations, the putative genera, according to Wagner and Fischer (2001), were indicated. The geographical distribution patterns of collected and identified taxa, and the comparison to known mycota of other Atlantic forest fragments were determined through literature.

RESULTS AND DISCUSSION

A total of 71 specimens of 26 distinct species (18 genera) were collected during the study (Table 1), comprising four distinct clades: polyporoid, hymenochaetoid, russuloid and euagarics. The great majority of the collected taxa were from polyporoid clade (13 genera, 18 species), accounting for approximately 70% of all species. All these species, as well as most of the taxa assigned to polyporoid clade, are characterized by a poroid hymenophore, dimitic to trimitic hyphal systems, and are wood decayers/facultative parasites (Hibbett and Thorn, 2001).

The species, *Pycnoporus sanguineus*, *Phellinus gilvus* (*Fuscoporia*), and *Lentinus crinitus*, accounted for one third of the total number of collected specimens, and were the commonest species found. Basidiomata of these three taxa not only occurred throughout the sampled period but also in high number at sampling. The aforementioned species are, by far, the most frequent taxa in other Atlantic Forest fragment inventories, especially in areas submitted to direct incidence of light as in forest gaps (Cavalcanti, 1976; Fonsêca, 1994; Gibertoni, 1999; Góes-Neto 1996; Gonçalves and Loguercio-Leite, 2001; Groposo and Loguercio-Leite, 2002; Gugliotta and Capellari, 1995; Gugliotta 1997; Jesus, 1993; Leite, 1990; Silveira and Guerrero, 1991). At least for *Pycnoporus sanguineus* and *Lentinus crinitus*, growth data supports the hypothesis that these species are adapted to low moisture and/or high temperatures (Lodge and Cantrell, 1995).

Two other species were collected relatively frequently: *Amauroderma omphalodes* and *Phellinus portoricensis* (*Fulvifomes*). These taxa, however, contrarily to the most frequent species, are not commonly observed in most of Atlantic Forest fragment inventories (Cavalcanti, 1976; Fonsêca, 1994; Gibertoni, 1999; Góes-Neto 1996; Gonçalves and Loguercio-Leite, 2001; Groposo and Loguercio-Leite, 2002; Gugliotta and Capellari, 1995; Gugliotta 1997; Jesus, 1993; Leite, 1990;

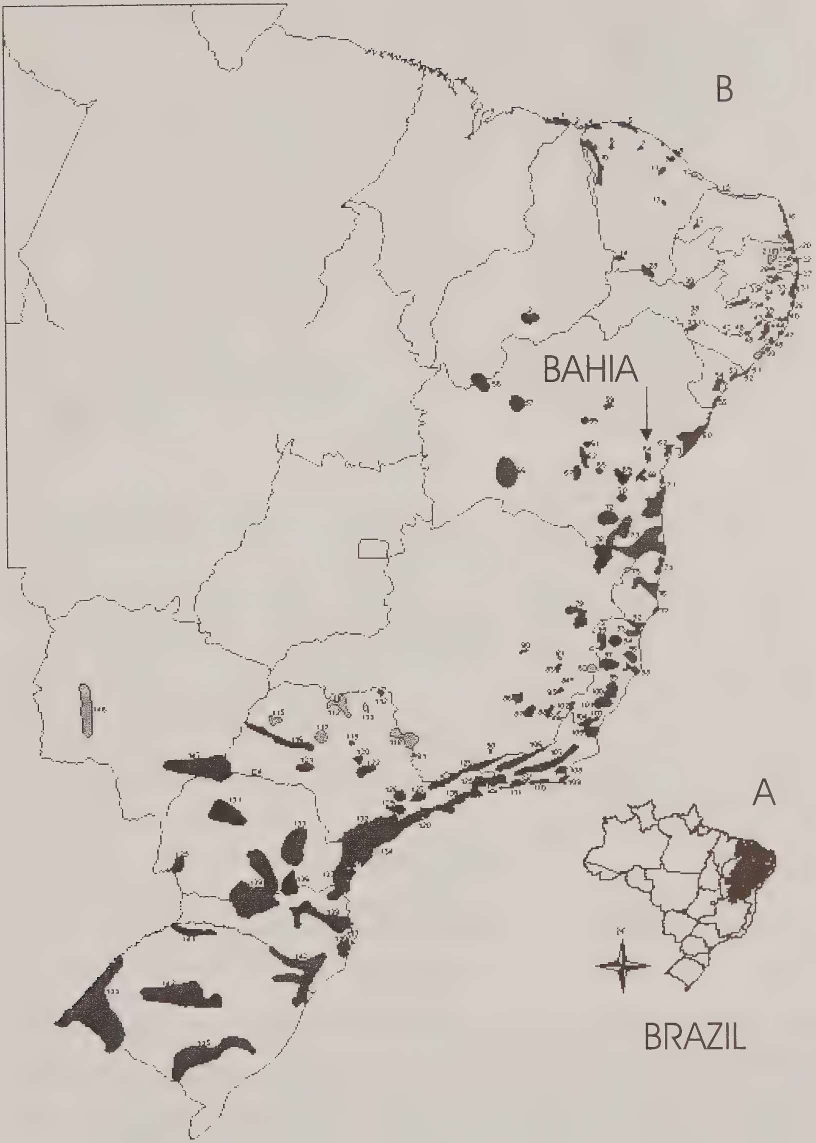

Fig. 1: A - The shadowed area comprises the Brazilian semi-arid region.
B - Priority conservation areas in Brazil's Atlantic Forest. The arrow indicates the studied area (Serra da Jibóia).

Silveira and Guerrero, 1991), which suggests that the apparently high frequency of those taxa in Serra da Jibóia could be related to a local specificity.

With the exception of *Gloeophyllum trabeum*, which is a brown-rot species, all taxa are typically white-rot fungi (Table 1), as expected for tropical species (Ryvarden, 1991), and in accordance with other known Atlantic forest inventories (Cavalcanti, 1976; Fonsêca, 1994; Gibertoni, 1999; Góes-Neto 1996; Gonçalves and Loguercio-Leite, 2001; Groposo and Loguercio-Leite, 2002; Gugliotta and Capellari, 1995; Gugliotta 1997; Jesus, 1993; Leite, 1990; Silveira and Guerrero, 1991).

All but one taxa occurred in fallen wood or dead trees still upright. Approximately 30% of *Phellinus portoricensis* (*Fulvifomes*) specimens were found in the trunk of living trees, and this habit was expected, as the species is known to be parasitic on several dicots (Fidalgo, 1968).

Most of the taxa are pantropical (62%) and less than one third of species are neotropical. This general pattern also occurred in other Atlantic Forest inventories, although the percentage of neotropical species is usually higher than that observed in the present work (Cavalcanti, 1976; Fonsêca, 1994; Gibertoni, 1999; Góes-Neto 1996; Gonçalves and Loguercio-Leite, 2001; Groposo and Loguercio-Leite, 2002; Gugliotta and Capellari, 1995; Gugliotta 1997; Jesus, 1993; Leite, 1990; Silveira and Guerrero, 1991).

CONCLUSION

Although surrounded by the semi-arid Caatinga vegetation and presumably isolated from the conventional Atlantic Forest region, the inventoried mycota of the studied submontane fragment seems to have no marked differences from the mycota of other fragments situated in the traditional domain of Atlantic Forest in lower altitudes. Most of the sampled taxa are pantropical, white-rot species, belonging to the polyporoid clade. Furthermore, the most frequently collected taxa, both in number of specimens and in occurrence along the sampling period, were also seen in the other surveys. One study, in the same area, comprising the diversity of a taxonomically distant group, flowering plants, also concluded that there were no significant differences between this fragment and other ones in the typical Atlantic Forest zone (Carvalho-Sobrinho and Queiroz, 2002). Thus, with the present work, this conclusion could also be extended to the lignolitic aphyllophoroid mycota. This pattern could be related to the fact that the studied fragment is not too far from the seaside. However, further studies in Atlantic Forest fragments in semi-arid region must be carried out to test this hypothesis.

ACKNOWLEDGEMENTS

We would like to thank all the people that contributed directly or indirectly to this work and, especially, to Dr. James Ginns, for his exhaustive review and invaluable criticism.

LITERATURE CITED

Brasil, Ministério do Meio Ambiente. 2000. *Avaliação e ações prioritárias para a conservação dos biomas Floresta Atlântica e Campos Sulinos*. Brasília. 40p.

Carvalho-Sobrinho, J. G. de and Queiroz, L. P. de. 2002. *Análise Fitogeográfica do Estrato Arbóreo da Mata Higrófila da Serra da Jibóia, Santa Terezinha-BA*. Feira de Santana. 36p.

Cavalcanti, M. A. de Q. 1976. *Introdução ao Conhecimento dos Basidiomicetos Poliporóides da Zona da Mata de Pernambuco*. Tese de Livre Docência, Universidade Federal de Pernambuco. Recife. 200p.

Fidalgo, O. 1968. *Phellinus pachyphloeus* and its allies. *Mem. N. York Bot. Gard.* **17**: 35-108.

Fonsêca, M. P. 1994. *Aphyllophorales da Reserva Estadual Armando de Salles Oliveira*, São Paulo, SP. Dissertação de Mestrado, Universidade de São Paulo. 171p.

TABLE 1: Lignicolous taxa collected in Serra da Jibóia between November 1999 to February 2002

Taxon	**Voucher (HUEFS)**	**Clade**	**% Total No. Specimens**	**Geographic Distribution Pattern**	**Wood Degradation Pattern**
Amauroderma omphalodes (Berk.) Imazeki	61521	polyporoid	8.75	neotropical	white rot
Cymatoderma caperatum (Berk. & Mont.) D.A. Reid	61530	russuloid	2.50	neotropical	white rot
Datronia caperata (Berk.) Ryvarden	61532	polyporoid	5.00	pantropical	white rot
Earliella scabrosa (Pers.) Gilb. & Ryvarden	61523	polyporoid	3.75	pantropical	white rot
Fomitella supina (Sw.) Murrill	61537	polyporoid	1.25	neotropical	white rot
Ganoderma australe (Fr.) Pat.	61533	polyporoid	1.25	pantropical	white rot
Gloeophyllum trabeum (Pers.) Murrill	61555	polyporoid	1.25	pantropical	brown rot
Hexagonia hydnoides (Schwartz) M. Fidalgo	61550	polyporoid	1.25	pantropical	white rot
Lentinus crinitus (L.) Fr.	61514	polyporoid	10.00	pantropical	white rot
Phellinus gilvus (Schwein.) Pat. (*Fuscoporia*)	61515	hymenochaetoid	11.25	pantropical	white rot
Phellinus melleoporus (Murrill) Ryvarden (*Fulvifomes*)	61540	hymenochaetoid	1.25	neotropical	white rot
Phellinus piptadeniae Teixeira (*Fulvifomes*)	61517	hymenochaetoid	1.25	neotropical	white rot
Phellinus portoricensis (Overh.) O. Fidalgo (*Fulvifomes*)	61534	hymenochaetoid	7.50	neotropical	white rot
Phellinus rimosus (Berk.) Pilát (*Fulvifomes*)	61552	hymenochaetoid	1.25	pantropical	white rot
Pycnoporus sanguineus (L.) Murrill	61520	polyporoid	12.5	pantropical	white rot
Polyporus dictyopus Mont.	61543	polyporoid	5.00	pantropical	white rot
Polyporus grammocephalus Berk.	61546	polyporoid	1.25	pantropical	white rot
Polyporus tenuiculus (Beauvais) Fr.	61519	polyporoid	1.25	pantropical	white rot
Rigidoporus microporus (Sw.) Overeem	61547	polyporoid	2.50	pantropical	white rot
Schizophyllum commune (L.) Fr.	61518	euagarics	1.25	cosmopolitan	white rot
Stereum ostrea Nees	61539	russuloid	5.00	cosmopolitan	white rot
Trametes elegans (Spreng.) Fr.	61526	polyporoid	1.25	pantropical	white rot
Trametes versicolor (L.) Lloyd	61524	polyporoid	1.25	cosmopolitan	white rot
Trametes villosa (Sw.) Kreisel	61522	polyporoid	6.25	pantropical	white rot
Tyromyces duracinus (Pat.) Murrill	61531	polyporoid	1.25	pantropical	white rot
Tyromyces leucomallus (Berk. & M.A. Curtis) Murrill	61513	polyporoid	3.75	neotropical	white rot

Gibertoni, T. B. 1999. *Basidiomycotina (Aphyllophorales) em áreas de Mata Atlântica de Pernambuco.* Dissertação de Mestrado, Universidade Federal de Pernambuco. 130p.

Góes-Neto, A. 1996. Biodiversidade de mixomicetos e fungos macroscópicos da Reserva Biológica de Una e áreas adjacentes (Bahia, Brasil). *Sitientibus* **15**: 91-108.

Gonçalves, G. V. C. and Loguercio-Leite, C. 2001. Biodiversidade de fungos poróides xilófilos (Basidiomycetes) na Unidade de Conservação Desterro (UCAD), Ilha de Santa Catarina, Brasil. *Insula* **30**: 1-19.

Groposo, C. and Loguercio-Leite, C. 2002. Fungos poliporóides xilófilos (Basidiomycetes) da Reserva Biológica Tancredo Neves, Cachoeirinha, Rio Grande do Sul, Brasil. *Iheringia* **57**: 39-59.

Gugliotta, A de M. and Capellari, M. 1995. Polyporaceae from Ilha do Cardoso, SP, Brazil. *Mycotaxon* **56**: 107-113.

Gugliotta, A. de M. 1997. Polyporaceae da mata ciliar da Estação Experimental e Reserva Biológica de Moji-Guaçu, SP, Brasil. *Hoehnea* **24**: 89-106.

Hibbett, D. S. and Thorn, R. G. 2001. Basidiomycota: Homobasidiomycetes. *In* "The Mycota VII Part B Systematics and Evolution" (McLaughlin, D. J.; McLaughlin, E. J. and Lemke, P. A., Eds.), pp. 121-168, Springer-Verlag, Berlin. 259p.

Jesus, M.A. 1993. Basidiomicetos lignocelulolíticos de floresta nativa e de *Pinus eliottii* Engelm. do Parque Estadual das Fontes do Ipiranga, São Paulo, SP. *Hoehnea* **20**: 119-126.

Kirk, P. M., Canon, P. F., David, J. C. and Stalpers, J. A. 2001. *Ainsworth & Bisby's Dictionary of the Fungi.* 9th Edition. CAB International, Wallingford. 624p.

Leite, C. L. 1990. *Políporos (Basidiomycotina) xilófilos de la Ilha de Santa Catarina, Santa Catarina, Brasil.* Tesis de Doctorado, Universidad de Buenos Aires. 329p.

Lodge, D. J. and Cantrell, S. 1995. Fungal communities in wet tropical forests: variation in time and space. *Can. J. Bot.* **73** (Suppl. 1): S1391-S1398.

Myers, N., Mittermeier, R. A., Mittermeier, C. G., da Fonseca, G. A. B. and Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* **403**: 853-858.

Ryvarden, L. 1991. Genera of Polypores. *Synopsis Fungorum 5.* Oslo: Fungiflora. 363p.

Silveira, R. M. B. and Guerrero, R. T. 1991. Aphyllophorales poliporóides (Basidiomycetes) de Aparados da Serra, Rio Grande do Sul. *Boletim do Instituto de Biociências* **48**:1-127.

Wagner, T. and Fischer, M. 2001. Natural groups and a revised system for the European poroid Hymenochetales (Basidiomycota) supported by nLSU rDNA sequence data. *Mycol. Res.* **105**: 773-782.

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A NEW RECORD OF PESTALOTIOPSIS THEAE, EXISTING AS AN ENDOPHYTE ON CINNAMOMUM INERS IN THAILAND

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ABSTRACT

An endophytic fungus, *Pestalotiopsis theae* strain CTC5, was isolated from the cambium of *Cinnamomum iners* at the Siri Rukhachat Medicinal Plant Garden, Salaya campus of Mahidol University, Nakornprathom, Thailand. By regular scanning electron microscopy (SEM), a spheroid-like extension of this fungus appears on the three relatively long appendages that occur on each conidium. The isolate CTC5, also frequently produces the basal appendage with the small knob at the end. The high similarities of ITS1, 5.8S rDNA and ITS2 sequences strongly confirmed that the isolate CTC5 should be classified as *Pestalotiopsis theae* by virtue of 99.63% homology. *Pestalotiopsis theae* is commonly known as a pathogen on leaves of *Thea sinnensis* and other plants. The combination of classical and molecular phylogenic classification may contribute a better understanding of evolutionary relationships among *Pestalotiopsis* isolates from diverse places and help explain relationships to their host plants. Furthermore, the new technique of environmental scanning electron microscopy is used herein to show the slimy nature of the conidiospores and that these appendages cannot be seen while the spores are in the acervulus.

Keywords: appendaged conidia, environmental scanning electron microscopy

INTRODUCTION

Intercellular tissues of higher plants in rainforests are known as hosts of great diversity of the fungal genus *Pestalotiopsis* (Raj, 1993). *Pestalotiopsis* is one of the anamorphs of *Pestalosphaeria*, a teleomorphic member in the family Amphisphaeriaceae (Barr, 1975; Sutton, 1980). There is an ongoing interest in these fungi because of their potential to yield pharmaceutical-based compounds. For example, *P. microspora* is a common endophyte found in tropical and subtropical plants and has been determined to be a producer of taxol, an anticancer drug (Li et al., 1996; Strobel et al., 1996; Strobel, 2002). Furthermore, *P. microspora*, an isolate from Papua New

Guinea, produces a unique isobenzofuranone-isopestacin, possessing antifungal and antioxidant activities (Strobel et al., 2002). Thus, the isolation and characterization of other isolates of *Pestalotiopsis* may increase the opportunities of finding other novel, bioactive compounds useful for medicinal or agrochemical applications (Strobel, 2002). However, the morphological classification of *Pestalotiopsis,* particularly at the species level, is very difficult because only a few of the teleomorphs of this fungus have ever been observed (Barr, 1975 and 1994; Metz et al., 2000).

At present, the increasing availability of nucleotide data such as rDNA sequence information is helping mycologists to identify these ambiguous fungi (Bruns et al., 1991). Several regions of rRNA genes, including the internal transcribed spacers, ITS1&2, evolve at rates different enough to recognize taxa at different ranks (Bruns et al., 1991; Berbee and Taylor, 1995; Mitchell et al., 1995). The ITS1&2 and 5.8S rDNA regions are very useful to delineate the genus *Pestalotiopsis* at the species level, and are consistent with the morphological classification (Worapong et al., 2002; Jeewon et al., 2003). Furthermore, both scanning electron microscopy (SEM) and new environmental scanning electron microscopy (ESEM) techniques have been applied to illustrate the morphology of the fungus that has been targeted for identification. Thus, this report describes the isolation and characterization of an endophytic strain of *P. theae* (CTC5) in the cambium of a healthy cinnamon tree by using both morphological characteristics and sequence analysis of ITS/5.8S rDNA as compared to an authentic strain of *P. theae*.

MATERIALS AND METHODS

Strain Isolation and Microscopic Observation

Representative healthy twigs of *Cinnamomum iners* Blume (Lauraceae) were taken from the Siri Rukhachat Medicinal Plant Garden, Salaya campus, Mahidol University, Nakornprathom, Thailand. They were about 15.0 cm long and 1.0 cm in diameter. The twig pieces were cut into pieces 1.0 cm long and thoroughly treated with 70% ethanol for several minutes. The outer bark was removed with a scalpel. Small pieces of inner bark and whitish cambium were aseptically removed and placed on water agar. Pure fungal cultures were obtained by hyphal tip cutting after incubation for a few days. Hyphal tips of developing isolate designated –"CTC5" were aseptically removed and placed on potato dextrose agar (PDA) for five days. After that, fungal colonies were transferred to water agar with gamma irradiated carnation leaves and sterile Thai cinnamon leaves (0.5X0.5 cm) to encourage spore production. For storage, pure cultures of CTC5, agar plugs containing the fungus, were added to vials containing sterile distilled water and stored at 4°C. Also, the conidia of CTC5 were placed in vials containing 15% glycerol and were preserved at -70°C.

The three hundred conidia produced by CTC5 were examined under a light microscope (Olympus). Raw data were used to calculate the mean and standard deviation for measurements of conidia and acervuli.

Scanning Electron Microscopy

Scanning electron microscopy was performed on isolate CTC5 by placing agar pieces, leaves and other plant parts supporting fungal growth into #1 Whatman filter paper packets. The packets were made by folding the filter paper over a piece of cord (1.5 cm). The packets were tied with cotton string and two removable split shot sinkers (ca. 3.25 gm each) were attached next to the packets to hold them under the surface of the dehydrating solutions and the liquid carbon dioxide during critical point drying. The preparation was then placed into 2% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2-7.4) with Triton X, wetting agent, aspirated for 5 minutes and left overnight.

The next day they were washed in 6 changes of water-buffer, followed by three 15 min. changes in 10% ethanol, four 15 min. changes of 30% ethanol, five 15 min. changes of 50% ethanol and left for two days in 70% ethanol. They were then rinsed in five 15 min. changes of 95% ethanol and then five 15 min. changes in 100% ethanol. The dehydration process was slowly done to discourage the processes of spore shriveling which may occur during rapid dehydration. Ultimately, the biological material was critical point dried, gold sputter coated and examined with a JEOL 6100 scanning electron microscope (SEM).

Environmental Scanning Electron Microscopy

Fresh or non-treated specimens were also examined by environmental scanning microscopy and images were recorded with a Philips XL 30 ESEM FEG. A gaseous secondary electron detector was used with a spot size of 3, at 15 kV. The temperature was 4°C with a chamber pressure which ranged from 5 to 6 Torr providing humidity from 8-10% at the sample.

Fungal Culturing

The fungus was grown on PDA (Difco, Laboratories, Detroit, Michigan, USA) and water agar with sterile small pieces of leaves and limbs to encourage spore production. Agar plugs containing the fungus were placed in sterile distilled water and stored at 4°C. Also, conidia were placed in 15% glycerol and stored at -70°C at department of Biotechnology, faculty of Science, Mahidol University, Rama VI Rd., Bangkok 10400, Thailand.

Fungal DNA Isolation and Amplification of Internally Transcribed Space (ITS) and 5.8S rDNA Sequences

For DNA isolation, CTC5 was grown in 5.0 ml potato dextrose broth in a Petri dish for two days at 23°C. The mycelium was harvested by centrifugation and washed twice with sterile ddH_2O. Total genomic DNA was extracted by the methods of Lee and Taylor (1990). Then, ITS/5.8S rDNA regions of the test fungus CTC5 were amplified using Mastercycler® personal thermo cycler (**Eppendorf**, Germany). For PCR reaction the universal primers, ITS5 5' GGAAGTAAAAGTCGTAACAAGG 3' and ITS4 5' TCCTCCGCTTATTGATATGC 3', (White *et al.* 1990) were used. PCR was performed in a 50 µl reaction containing 0.1 µg genomic DNA, 0.4 µM each primer, 0.16 mM four dNTPs and 1 unit Master *Taq* polymerase (**Eppendorf**) in a buffer of 10X Reaction buffer included 1.5 mM Mg^{2+} and 5X TaqMaster PCR Enhancer. PCR cycling conditions consisted of denaturation at 94°C for 1.5 min, annealing at 55°C for 2.5 min, and extension at 72°C for 3 min for 40 cycles, with a final extension at 72°C for 10 min (Willits and Sherwood, 1999). Agarose gel electrophoresis and followed by UV spectrometry were then used to examine for the PCR product (Bio Imaging Systems, SYNGENE, Synoptics Limited, Cambridge, United Kingdom). The PCR product of strain CTC5 was sent to the BIOSERVICE UNIT, National Science and Technology Development Agency for sequencing. Comparison and alignment sequences were done by using Clustal W version 1.7 (Thomson and Gibson, 1997), and manually aligned afterward. Nucleotide sequences of ITS/5.8S rDNA regions of the CTC5 were determined manually on both strands and submitted to Genbank with a serial number **AY163167**.

Searching and Comparison ITS 1&2 /5.8S rDNA sequences

ITS1&2/5.8S rDNA sequences of culture collection CTC5, also known as *Pestalotiopsis theae*, were searched and compared with other fungal sequences under

Blast 2.1 and a search of NCBI at the web site http://www.ncbi.nlm.nih.gov/BLAST. Comparison and alignment sequences were done by using Standard nucleotide- BLAST [blastn] at http://www.ncbi.nlm.nih.gov/BLAST.

RESULTS AND DISCUSSION

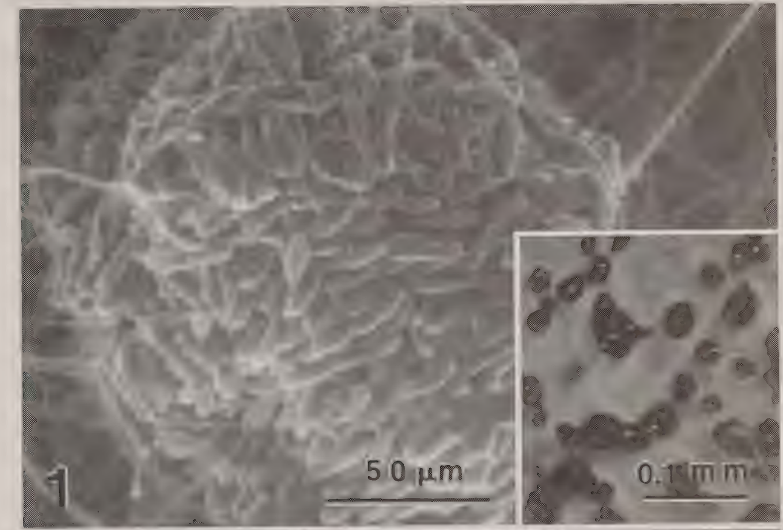
Pestalotiopsis theae (Swada) Steyaert.

The fungus strain CTC5, grown on water agar plus carnation leaves, producing scattered acervuli that are erumpent, pimple-like, unilocular, and oval to irregular (Fig.1). **Acervuli** range from 230-250 μm in diameter and 300-370 μm in height and appear to be covered with slimy material by ESEM (Fig. 1). **Conidia,** also when examined by ESEM, appear as if they are covered with a slimy material (Figs. 1 and 2). It is to be noted that ESEM probably gives a truer view of the actual native state of the spores and the acervuli constrictions since no fixation, washing and other procedures are needed to obtain actual ESEM images. In contrast, when regular SEM techniques are used to examine the spores, the appendages there on are easily observed (Fig. 3). Thus, the advantages of using comparative ESEM and SEM techniques are obvious. The conidiophores of CTC5 arise on the entire inner acervular wall. The conidia are long fusiform, 19-30X5-7 μm, with the average 20X6 μm, 4 septate, without constrictions at the septa (Fig. 1-4). The center 3 cells (15-19 μm) are yellow brown concolorous. The conical apical cell averages ca. 3.0 μm in length and 2.4 μm in width. The basal cell averages ca. 4.78 μm in length and 3.25 μm in width and are characteristically gluttate. Both apical and basal cells are hyaline pale green. **Appendages** appear on each conidium with one at the basal cell, and 2-4 (commonly 3) arising at the juncture of the conical apical cell (Fig. 3-4). The appendages of the upper cell 0.6-1.0 μm in diameter are terminated with a spheroidal tip (1.2-1.5 μm in diameter, averaging 1.5 μm, Fig. 4). Each appendage averages 32.5 μm in length on mature spores and overall ranging from 24-45 μm. The basal appendage is 0.5 μm in diameter and 3-5 μm in length (averaging 3.5 μm) with the small knob at the end (0.8 μm in diameter, Fig. 4). In these respects the fungus should be classified as *P. theae* (Swada) Steyaert (Raj, 1993).

Comparative Taxonomy and Molecular Biology of *Pestalotiopsis theae* isolate CTC5 to other *Pestalotiopsis* spp.

A fungal endophyte CTC5 was identified as *Pestalotiopsis theae* (Swada) Steyaert based upon its comparable morphological characteristics and molecular phylogenetic analyses. Considering the morphological classification done by Guba (1961), the isolate CTC5 has many general morphological characteristics that are classified under the section of *Quinqueloculatae*; conidia 5 celled with three intermediate colored cells; setulae knobbed at the extremities (Spathulatae); colored cells brown, or yellow brown, concolorous. The endophytic CTC5 resembles other species of *Pestalotiopsis,* namely *P. fici*, *P. elastica*, *P. annulata* that were described by Guba (1961), as well as *P. jesteri* that was reported by Strobel et al., (2000). However, the *P. theae* CTC5 in this report is distinct from *P. elastica* and other species by several important morphological characteristics. It differs from *P. elastica*, the most closely related taxonomic type, mainly by the frequently terminally knobbed basal appendage (0.8 μm in diameter) and the number and length of apical appendages. The appendages of *P. theae* CTC5 are 2-4 setulae (commonly 3) averaging 32.5 μm in length on mature spores with an overall range from 24-55 μm. In contrast to *P. theae*, *P. elastica* has 3 setulae appendages varying from 18-35 μm in length and this is based on the monograph of *Monochaetia* and *Pestalotia* by Guba, 1961. *P. fici* produces bigger conidia (19-26X5-7 μm) with shorter apical appendages, 9-20 μm long (Guba, 1961).

For *P. annulata*, its conidia are broader (6.5-9.5 µm wide) with an apical appendage about the same length (Guba, 1961). Although the conidia of both *P. theae* CTC5 and *P. jesteri* possess three apical appendages with enlargements at the end, *P. jesteri* produces appendages arising near the juncture of the conical apical cell and the penultimate cell in the conidium.



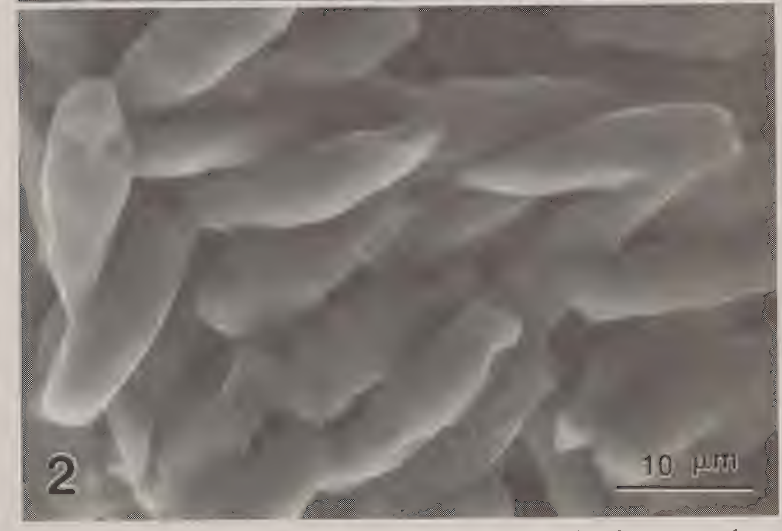
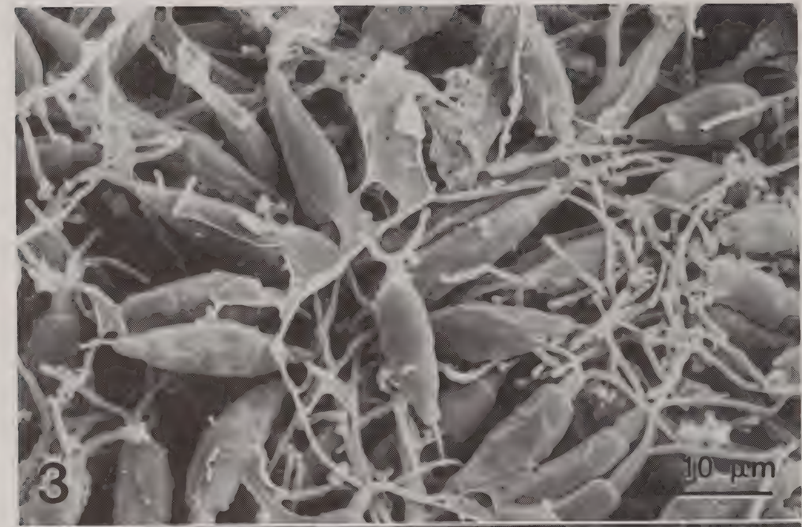


Fig. 1. An environmental scanning electron micrograph of an acervulus of *Pestalotiopsis theae* growing on a carnation leaf showing oozing developing conidia. The inset is a light micrograph of scattered acervuli.

Fig. 2. A scanning electron micrograph of developing young conidia of *P. theae*.



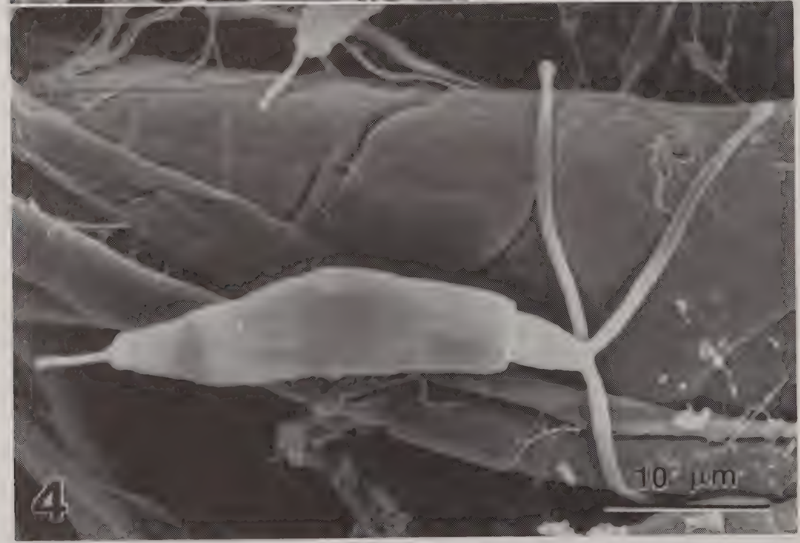


Fig. 3. A scanning electron micrograph of appendage-bearing conidiospores of *P. theae*.

Fig. 4. A scanning electron micrograph of a *P. theae* conidium showing the tiny knobs on the tips of the appendages.

In addition, genetic analysis of the ITS1&2 and the 5.8S rDNA sequence strongly indicated that the fungal endophyte CTC5 is identical to *P. theae*. Searching and comparison of ITS1&2 and 5.8S rDNA sequence with other fungal sequences under MEGA BLAST search showed a 99.63% similarity between the *Pestalotiopsis* isolate CTC5 and *P. theae*, which was isolated from *Protea mellifera* in South Africa (Genbank accession number AF405297, Jeewon et al., 2003). The ITS1&2 and 5.8S rDNA sequence of *P. theae* isolate CTC5 is also 99% similar to *Pestalotiopsis* sp. 5 (AF409992), isolated from an unidentified leaf, Hong Kong, China and *Pestalotiopsis* sp. 6 (AF409991), isolated from *Nepenthes truncate*, The Philippines. It is interesting to note that the 85% identity of the ITS1&2 and 5.8S rDNA between the isolate CTC5 *P. theae* and *P. jesteri* (AF377282) might correlate with the different positions in the ontogeny of the apical appendages on the conidia as mentioned previously. More species of *Pestalotiopsis* possessing the knob at the end of the apical and basal appendage, and the different positions of ontogeny of apical appendages should be studied in both morphological characteristics and molecular phylogenic classification methods. It may be a good idea to consider all the available information, both morphological and molecular data, to achieve a more accurate picture of the evolutionary relationships of these fascinating *Pestalotiopsis* species. Nonetheless, the evolution of conidial characters is not always written in the ribosomal genes, but the conidiation genes of these fungi, which to date, have not been studied.

Comparative Biology of *P. theae*

Generally, *P. theae* is described as a leaf pathogen on a number of species of such as *Klainedoxa jabonensis*, and *Theae sinensis* and others (Raj, 1993). Although a number of *Pestalotiopsis* spp. are known as endophytes it appears that *P. theae* has generally been considered only as a pathogen (Strobel et al., 1996; Raj, 1993; Redlin and Carris 1996). In fact *P. theae* is known to produce phytotoxins and is considered one of the gray blight fungi of tea (Nagata et al., 1992). Here we report for the first time that this organism can also exist as an endophyte. The host from which it was isolated showed no symptoms or signs of disease. It appears that this organism can act as many of the other *Pestalotiopsis* spp., that is, both as a pathogen and as an endophyte and this may be conditioned by the environment, and the genetics of the host and pathogen. In fact, several other isolates of *Pestalotiopsis* spp. appeared from healthy leaves of *Cinnamomum camphor* and *Caesalpinia sappan* growing in the same medicinal plant garden on the Salaya Campus, Mahidol University as *C. iners*, the subject of this report (Worapong, unpublished).

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REFERENCES

Barr, M. E. 1975. *Pestalosphaeria*, A new genus in the *Amphisphaeriaceae*. Mycologia 67: 187-194.

Barr, M. E. 1994. Notes on the Amphisphaeriaceae and related families. Mycotaxon 51: 191-224.

Berbee, M. L. and Taylor, J. W. 1995. From 18S ribosomal sequence data to evolution of morphology among the fungi. Canadian Journal of Botany 73 (Suppl. 1): S677-S683.

Bruns, T. D., White, T.J., and Taylor, J. W. 1991. Fungal molecular systematics. Annual Review Ecology Systematics 22: 525-564.

Jeewon, R., Liew, E. C. Y., Simpson, J. A., Hodgkiss, I. J., and Hyde, K. D. 2003. Phylogenetic significance of morphological characters in the taxonomy of *Pestalotiopsis* species. Molecular Phylogenetics and Evolution 27: 372-383.

Lee, S. B. and Taylor, J. W. 1990. Isolation of DNA from fungal mycelia and single spores. In PCR Protocols: A guide to Methods and Applications. Edited by Innis, M. A., Gelfand, D. H., Sninsky J. J., White, T. J. Academic press, Inc., California: 282-287.

Li, J. Y., Strobel, G. A., Sidhu, R., Hess, W. M., and Ford, E. J. 1996. Endophytic taxol producing fungi from Bald Cypress *Taxodium distichum*. Microbiology 142: 2223-2226.

Guba, E. F. 1961. Monograph of *Monochaetia* and *Pestalotia*. Harvard University Press, Massachusetts, USA.

Metz, A. M., Haddad, A., Worapong, J., Long, D. M., Ford, E. J., Hess, W. M. and Strobel, G. A. 2000. Induction of the sexual stage of *Pestalotiopsis microspora*, a taxol-producing fungus. Microbiology 146: 2079-2089.

Mitchell, J. I., Roberts, P. J., and Moss, S. T. 1995. Sequence or Structure? A short review on the application of nucleic acid sequence information to fungal taxonomy. Mycologist 9:67-75.

Nagata, T., Ando, Y., and Hirota, A. 1992. Phytotoxins from tea gray blight fungi, *Pestalotiopsis longiseta* and *Peatalotiopsis theae*. Bioscience Biotechnology and Biochemistry 56: 810-811.

Raj, N. 1993. Coelomycetous Anamorphs with Appendage Bearing conidia. Edwards Brothers Publication Co. Ann Arbor, Mich.

Redlin, S. C., and Carris, L. M. 1996. Endophytic Fungi in Grasses and Woody Plants. APS Press, St .Paul, Minnesota.

Strobel, G. A., Yang, X., Sears, J., Kramer, R., Sidhu, R. S., and Hess, W. M. 1996. Taxol from *Pestalotiopsis microspora*, an endophytic fungus of *Taxus wallachiana*. Microbiology 142: 435-440.

Strobel, G. A., Ford, E. J., Worapong, J., and Hess, W. M. 2000. *Pestalotiopsis jesteri* sp. nov. an endophyte from *Fragraea bodeni* from the southern highlands of Papua New Guinea. Mycotaxon 76: 257-266.

Strobel, G. A. 2002. Microbial gifts from rainforests. Canada Journal of Plant Pathology 24: 14-20.

Strobel, G. A., Ford, E. J., Worapong, J., Harper, J. K., Arif, A. M., Grant, D. M., Fung, P. C. W., and Chau, R. M. W. 2002. Isopestacin, a unique Isobenzofuranone from *Pestalotiopsis microspora* possessing antifungal and antioxidant activities. Phytochemistry 60 (2): 179-183.

Sutton, B. 1980. The Coelomycetes. CMI. Kew, Surrey, England.

Thomson, J. and Gibson, T. 1997. Clustal W Multiple Sequence Alignments. In: Documentation (Installation and Usage) European Molecular Biology Laboratory Postfach Germany, 1-37.

White, T. J., Bruns, T., and Taylor, J. W. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. In PCR Protocols: A guide to Methods and Applications. Edited by Innis, M. A., Gelfand, D. H., Sninsky J. J., White, T. J. Academic press, Inc., California: 315-322.

Willits, D. A. and Sherwood, J. E. 1999. Polymerase Chain Reaction detection of *Ustilago hordei* in leaves of susceptible and resistant barley varieties. Phytophathology 89: 212-217.

Worapong, J., Ford, E. J., Hess, W. M., and Strobel, G. A. 2002. The UV Light- induced conversion of *Pestalotiopsis* to *Monochaetia*-like. Fungal Diversity 9: 179-193.

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LIGNICOLOUS HOMOBASIDIOMYCETES NEWLY RECORDED FROM TAIWAN

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ABSTRACT

Twenty seven species of lignicolous homobasidiomycetes are recorded from Taiwan for the first time, *viz. Aleurodiscus cremicolor*, *A. grantii*, *A. penicillatus*, *Athelia binucleospora*, *A. bombacina*, *Candelabrochaete africana*, *Ceriporia mellea*, *C. tarda*, *Coltricia spathulata*, *Cotylidia carpatica*, *Dacryobolus phalloides*, *Flavodon flavus*, *Hyphoderma tsugae*, *Melanoporia nigra*, *Nigroporus durus*, *Phanerochaete nova-granata* comb. nov., *Phellinus rhabarbarinus*, *Podoscypha brasiliensis, P. simulans* stat. nov., *Radulomyces confluens*, *R. copelandii*, *Rigidoporus vitreus*, *Skeletocutis alutacea*, *Tomentellopsis echinosporum*, *Trametes nivosa*, *Trechispora rigida*, and *Tubulicrinis borealis.*

Key words: Aphyllophorales, Basidiomycota, taxonomy

LIST OF THE SPECIES

Aleurodiscus cremicolor Hjortstam & Ryvarden, Nordic J. Bot. 2(3): 273. 1982.

Specimens examined. Taiwan. Taipei: Yangminshan National Park, Hsaioyukeng, alt. 700 m, on culm of *Miscanthus sinensis*, leg. S.H. Wu et al., 21-VIII-2000, *Wu 0008-10* (TNM F12769). Nantou: Lienhuachih, alt. 700 m, on branch of angiosperm, leg. S.H. Wu *et al.*, 1-XII-1999, *Wu 9912-7* (TNM F10402).

Remarks. This species was known only from Thailand and Nepal (Núñez and Ryvarden, 1997).

Aleurodiscus grantii Lloyd, Mycol. Writ. 6: 927. 1920.

Specimen examined. Taiwan. Taichung: Hsuehshan, alt. 3,100 m, on trunk of *Abies* sp., leg. M.J. Lai, 21-VIII-2000, *Wu 0008-2* (TNM F12762).

Aleurodiscus penicillatus Burt, Ann. Mo. Bot. Gard. 5: 201. 1918.

Specimens examined. Taiwan. Chiayi: Yushan National Park, Lulin Villa, on branch of gymnosperm, leg. Y.Z. Wang, 8-XII-1994, *Wu 9412-46* (TNM F02959); Yushan National Park, Tatachia – Paiyun Villa, alt. 2,650 m, on branch of *Pinus taiwanensis*, leg. S.H. Wu, 12-VI-1996, *Wu 9606-20* (TNM F05054)

Remarks. Núñez and Ryvarden (1997) included Taiwan in the distribution area of this species, nevertheless without mentioning that any specimen had been studied. Until hitherto no specimen has been reported from Taiwan, this species is herein presented as new to Taiwan.

Athelia binucleospora J. Erikss. & Ryvarden, Cort. N. Eur. 2: 105. 1973.
Specimen examined. Taiwan. Taichung: Anmashan, alt. 2,250 m, on rotten trunk of gymnosperm, leg. S.H. Wu & J.C. Lo, 5-XII-2001, *Wu 0112-2* (TNM F13818).

Athelia bombacina (Link:Fr.) Pers., Mycol. Eur. 1: 85. 1822.
Specimen examined. Taiwan. Taichung: Anmashan, alt. 2,250 m, on branch of angiosperm, leg. S.H. Wu & J.C. Lo, 5-XII-2001, *Wu 0112-25* (TNM F13840).

Candelabrochaete africana Boidin
Specimen examined. Taiwan. Taipei: Yangminshan National Park, alt. 600 m, on branch of angiosperm, leg. S.H. Wu, 24-VII-1991, *Wu 910724-36* (TNM F15017).

Ceriporia mellea (Berk. & Broome) Ryvarden, Bull. Jard. Bot. Belg. 48: 98. 1978.
Specimens examined. Taiwan. Miaoli: Wushihkeng, alt. 700 m, on branch of angiosperm, leg. S.H. Wu & J.C. Lo, 18-IV-2003, *Wu 0304-11* (TNM F15061). Taitung: Orchid Island, on the way to Tienchih, alt. 200 m, on branch of angiosperm, leg. S.Z. Chen, 16-V-2003, *Chen 1272* (TNM F15060).

Ceriporia tarda (Berk.) Ginns, Mycotaxon 21: 326. 1984.
Specimen examined. Taiwan. Taichung: Tashueishan Forest Road 35 K, alt. 2,000 m, on branch of angiosperm, leg. S.H. Wu & J.Y. Tseng, 6-VI- 1995, *Wu 9506-64* (TNM F03650).

Coltricia spathulata (Hooker) Murrill, North Am. Fl. 9: 93. 1908.
Specimen examined. Taiwan. Taitung: Orchid Island, on the way to Tienchih, alt. 100 m, on branch of angiosperm, coll. S.Z. Chen, 16-V-2003, *Chen 1271* (TNM F15059).

Cotylidia carpatica (Pilát) Huijsman, Bull. Soc. Mycol. France 70: 57. 1954.
Specimen examined. Taiwan. Taipei: Yangminshan National Park, Luchiaokenghsi Protected Area, alt. 350 m, on fallen trunk of angiosperm beside a mountain stream, leg. S.H. Wu et al., 21-X-2000, *Wu 0008-6* (TNM F12766).

Remarks. Cotylidia carpatica was collected only once respectively in Czechoslovakia (type locality), Holland, and Java (Reid, 1965). Its distant geographical range and diverse climate adaptation is interesting to study, based on more collections. Reid (1965) mentioned that this species seems to prefer damp situation. The Taiwanian collection was made beside a stream, which fit the habitat of this species.

Dacryobolus phalloides, Manjón, Hjortstam & G. Moreno, Anales Jard. Bot. Madrid 40: 297. 1984.
Specimen examined. Taiwan. Nantou: Sun-Moon Lake, alt. 800 m, on branch of angiosperm, 21-II-2003, leg. S.H. Wu, *Wu 0302-2* (TNM F15056).

Remarks. Dacryobolus phalloides was recorded only from Spain (Manjón et al., 1984). It differs from *D. karstenii* (Bres.) Oberw. ex Parmasto in having larger spores.

Flavodon flavus (Klotzsch) Ryvarden, Norw. J. Bot. 20: 3. 1973.
Specimen examined. Taiwan. Pingtung: Kengting National Park, Lungluantan, on branch of angiosperm, leg. S.Z. Chen, 10-X-2002, *Chen 1246* (TNM F15057).

Hyphoderma tsugae (Burt) J. Erikss. & Å. Strid, Cort. N. Eur. 3: 541. 1975.
Specimen examined. Taiwan. Taichung: Anmashan, alt. 2250 m, leg. S.H. Wu et al., 27-VI-2002, Wu 0206-5 (TNM F14680).

Melanoporia nigra (Berk.) Murrill, North Am. Flora 9: 14. 1907.
Specimen examined. Taiwan. Nantou: Lienhuachih, alt. 700 m, on branch of angiosperm, leg. W.N. Chou, 28-XII-1995, *CWN 01371* (TNM F4774).

Nigroporus durus (Jungh.) Murrill, Bull. Torrey Bot. Cl. 34: 471. 1907.
Specimens examined. Taiwan. Taipei: Linkou, on wood, leg. C.H. Chung, 29-VI-1997, *Wu 9706-2* (TNM F10420). Nantou: Lienhuachih, alt. 700 m, on branch of

angiosperm, leg. S.Z. Chen, 5-IX-1994, *Chen 212* (TNM F02756). Taitung: Orchid Island, Hungtoushan, alt. 400 m, on trunk of angiosperm, leg. S.Z. Chen, 23-IV-1997, *Chen 649* (TNM F08829); Orchid Island, on the way to Tienchih, alt. 400 m, on fallen trunk of angiosperm, leg. S.Z. Chen, 15-VII-2000, *Chen 1013* (TNM F12012).

Phanerochaete nova-granata (Welden) Sheng H. Wu, comb. nov.
Basionym: *Lopharia nova-granata* Welden, Mycologia 67: 540. 1975.
≡ *Porostereum nova-granatum* (Welden) Hjortstam & Ryvarden, Synop. Fungorum 4: 41. 1990.
Specimens examined. Colombia: Depto. Valle: La Palestina, on bamboo, leg. A.L. Welden, 17-VI-1968, (holotype, NY). Taiwan. Hualien, Tailuguo, Baiyang Walking Road, alt. 450 m, on culm of Poaceae, leg. S.H. Wu et al., 10-IX-2001, *Wu 0109-17* (TNM F13762). Vietnam: Ba Vi National Park, alt. 650 m, on culm of bamboo, leg. S.H. Wu & S.Z. Chen, 4-VII-1998, *Wu 9807-81* (TNM F09066).

Remarks. Phanerochaete nova-granata is characterized in having resupinate basidiocarps, simple-septate hyphae, pale-brown skeletal cystidia, and was collected from Poaceae including bamboo. *Phanerochaete crassa* (Lév.) Burds. resembles this species, differs in having effused-pileate basidiocarp, and was not reported from Poaceae. Hjortstam and Ryvarden (1990) reported basidiospores of *P. nova-granata* as 5.5-7 x 3-4 μm. My measurement of its spores ranged 6-7.5 x 3-3.8 μm. The specimens of Taiwan and Vietnam have smaller spores measured ca. 5-6 x 2.8-3.5 μm. Hymenial surface of old part of the type specimen is extensively cracked, while it is not cracked in young part. Hymenial surfaces of Taiwan and Vietnam specimens are not cracked, probably representing young collections. Despite of deviation of spore dimension, other features of Taiwan and Vietnam specimens fit those of the type specimen very well. The two south Asian specimens are tentatively regarded as *P. nova-granata* with smaller basidiospores. The author accepts the viewpoint that *Phanerochaete* can accommodate species with skeletal cystidia, thus propose this new combination.

Phellinus rhabarbarinus (Berk.) G. Cunn., New Zealand Dept. Sci. Ind. Res. Bull. 164: 229. 1965.
Specimens examined. Taiwan. Nantou: Lienhuachih, alt. 700 m, on branch of angiosperm, leg. W.N. Chou, 8-IV-1994, *CWN 00250* (TNM F01987). Chiayi City: on stump of angiosperm, leg. S.H. Wu, 15-X-2001, *Wu 0110-1* (TNM F013794).

Podoscypha brasiliensis D.A.Reid, Beih. Zur Nova Hedw. 18: 169. 1965.
Specimen examined. Taiwan. Taitung: Taitung Forest Park, alt. 10 m, on buried rotten wood, leg. S.Z. Chen, 24-VIII-2002, *Chen 1116* (TNM F14762).
Remarks. This species was reported only from Brazil (Reid, 1965).

Podoscypha simulans (D.A. Reid) Sheng H. Wu, stat. nov.
Basionym: *Podoscypha fulvo-nitens* (Berk.) D.A. Reid var. *simulans* D.A. Reid, Beih. Zur Nova Hedw. 18: 179. 1965.
Specimen examined. Taiwan. Chiayi: Yushan National Park, Nanhsi Forest Road, alt. 1,800 m, on branch of angiosperm, leg. S.H. Wu & S.Z. Chen, 13-VI-1996, *Wu 9606-34* (TNM F05066).

Remarks. Reid (1965) distinguished *Podoscypha fulvo-nitens* var. *simulans* from *P. fulvo-nitens* var. *fulvo-nitens* by its larger basidiospores ((3.2-)3.75-4.75(-5.75) x 2-2.75(-3)) μm vs. (2.2-)2.75-4(-4.2) x (1.2-)1.75-2.2μm). The specimen from Taiwan has spores measured by the author as 4-5 x 2.5-3μm, distinctly larger than those of *P. fulvo-nitens* var. *fulvo-nitens*. The Taiwanian specimen and other collections representative of *P. fulvo-nitens* var. *simulans*, should be separated from *P. fulvo-*

nitens var. *fulvo-nitens*, and the treatment is proposed here.

Radulomyces confluens (Fr.:Fr.) M.P. Christ., Dansk Bot. Ark. 19 (2): 230. 1960.
Specimens examined. Taiwan. Chiayi: Tatachia – Paiyun Villa, alt. 2,600 m, on branch of angiosperm, leg. S.H. Wu, 12-VI-1996, *Wu 9606-4* (TNM F05037); alt. 2,650 m, *Wu 9606-11* (TNM F05046).

Radulomyces copelandii Hjortstam & Spooner, Kew Bull. 45: 314. 1990.
Specimen examined. Taiwan. Chiayi: Tatachia – Paiyun Villa, alt. 2,600 m, on branch of *Coriaria japonica* ssp. *intermedia*, leg. S.H. Wu, 12-VI-1996, *Wu 9606-5* (TNM F05038).

Rigidoporus vitreus (Fr.) Donk, Persoonia 4: 34. 1966.
Specimens examined. Taiwan. Taipei: Yangminshan National Park, Luchiaokenghsi Protected Area, alt. 350 m, on branch of angiosperm, leg. S.H. Wu et al., 21-X-2000, *Wu 0008-8* (TNM F12768); on rotten trunk of angiosperm, leg. S.H. Wu et al., 15-VI-2001, *Wu 0106-21* (TNM F13444).

Skeletocutis alutacea (Lowe) Keller, Persoonia 10: 353. 1979.
Specimen examined. Taiwan. Taichung: Anmashan, alt. 2,250 m, on branch of gymnosperm, leg. S.H. Wu et al., 27-VI-2002, *Wu 0206-2* (TNM F14677).

Tomentellopsis echinospora (Ellis) Hjortstam, Svensk Bot. Tidskr. 64: 425. 1970.
Specimen examined. Taiwan. Taichung: Wushihkeng, alt. 900 m, on branch of angiosperm, coll. S.H. Wu & J.C. Lo, 18-IV-2003, *Wu 0304-23* (TNM F15061).

Trametes nivosa (Berk.) Murrill, North Am. Fl. 9: 42. 1907.
Specimens examined. Taiwan. Taitung: Orchid Island, on the way to Tienchih, alt. 250 m, on branch of angiosperm, leg. S.Z. Chen, 26-VIII-2002, *Chen 1177* (TNM F14784); alt. 100 m, on trunk of *Eurya emarginata*, leg. S.Z. Chen, 16-V-2003, *Chen 1269* (TNM F15058).

Remarks. This species is widespread in South and Central America, rarely found in Africa (Ryvarden and Johansen, 1980), and is newly recorded from tropical Taiwan.

Trechispora rigida (Berk.) K.H. Larss., Nordic J. Bot. 16: 92. 1996.
Specimen examined. Taiwan. Taipei: Yangminshan National Park, Luchiaokenghsi Protected Area, alt. 350 m, on rotten branch of angiosperm, leg. S.H. Wu et al., 21-X-2000, *Wu 0008-5* (TNM F12765).

Tubulicrinis borealis J. Erikss., Symb. Bot. Upsal. 16(1): 79. 1958.
Specimen examined. Taiwan. Taichung: Anmashan, alt. 2,250 m, on branch of gymnosperm, leg. S.H. Wu & J.C. Lo, 5-XII-2001, *Wu 0112-9* (TNM F13825).

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LITERATURE CITED

Hjortstam, K. and L. Ryvarden, L. *Lopharia* and *Porostereum* (Corticiaceae). Synop. Fung. 4: 1-68. 1990.

Manjón, J.L., K. Hjortstam, and G. Moreno. 1984. *Dacryobolus phalloides* sp. nov. (Corticiaceae). Anales Jard. Bot. Madrid 40: 297-301.

Núñez, M. and L. Ryvarden. 1997. The genus *Aleurodiscus* (Basidiomycotina). Synop. Fung. 12: 1-164.

Reid, D.A. 1965. A monograph of the stipitate stereoid fungi. Beih. Zur Nova Hedwigia 18: 1-382.

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NEW AND INTERESTING SPECIES OF LACTARIUS FROM INDIA

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ABSTRACT

Two species, viz., *Lactarius abbotanus* and *L. mayawatianus*, of the family Russulaceae are described and illustrated as new species. *Lactarius subindigo* is reported for the first time from India.

Key words: Russulaceae, ectomycorrhizae, Kumaon Himalaya

INTRODUCTION

During investigation of the Russulaceae of the Kumaon Himalaya, intensive foraying led to the collection of three interesting species of the genus *Lactarius* of which there was known only 68 taxa from India (Das & Sharma 2001). Critical observations on their distinct macro- and microscopic characters revealed two of them to be new to science and have been named as *Lactarius abbotanus* and *L. mayawatianus*, whereas the third one *L. subindigo* is a new record to India. Herbaria housing the cited collections are abbreviated in accordance with Holmgren *et al*. (1990).

MATERIAL AND METHODS

Colour terminology used is after Kelly & Judd (1955). Morphological characters are recorded on fresh basidiomes. Microscopical observations, measurements and camera lucida drawings were made on materials mounted in 5% KOH, Melzer's reagent, Lactophenol-cotton blue, Congo-red and Carbol fuchsin. For measurement of spores, *n* number of spores were taken and '**Q**' value (**L**/**B** ratio) was calculated by considering the mean value of length and width. The line drawings are prepared by K. Das. Spores for Scanning Electron Microphotographs were obtained from gill samples which were pretreated gradually in acetone-alcohol and acetone and mounted on double faced adhesive tape. Spores were coated with a layer of gold-paladium and observed under PHILIPS PSEM 515 HOLLAND.

RESULTS AND DISCUSSION

Lactarius abbotanus K. Das & J.R. Sharma, **sp. nov.** (Fig. 1, 4 a, b & c)

Pileus 64-83 mm diam., convexus, ad infundibuliformis depressusque, glutinosus. Lamellae remotus, late adnatus, luteoalbus. Stipes 38-45 x 14-18 mm, cylindricus, scrobiculatus. Latex albus, lente luteus. Sporae 8.3-10.5 x 7.4-8.0 µm, subglobosae ad ellipsoidae, amyloidae. Typus: India, Uttaranchal, Champawat, Abbot Mount, KD4524 (Holotypus BSD; Isotypus GENT).

Etymology. The epithet *abbotanus* refers to the locality where the type material was collected (Abbot Mount, Champawat, Uttaranchal, India).

Pileus 64-83 mm diam., convex with depressed center, becoming deeply depressed to funnel shaped with age; cuticle glutinous, sticky, azonate, increasingly hairy towards margin, dark to deep orange yellow when young, brilliant yellow to orange yellow at maturity; margin decurved to inrolled, hairy, hairs long, up to 7 mm, slimy. **Lamellae** broadly adnate, distant (*ca* 4 per 10 mm), yellowish white, lamellulae in two rows. **Stipe** 38-45 x 14-18 mm, cylindrical or with broader base, hollow, yellowish white to pale yellow becoming soft orange yellow after bruising, distinctly scrobiculate or pitted, pits medium to soft orange yellow, base hairy. Context pale yellow, brilliant yellow on exposure. **Latex** white, immediately brilliant to yellow on exposure.

Spores 8.3-10.5 x 7.4-8.0 µm (n = 20, Q = 1.06-1.34), subglobose to ellipsoid, amyloid, ornamentation up to 1 µm high, composed of uneven ridges with acute edges forming partially complete reticulation, often spiny, connected with fine lines. **Basidia** 32-43 x 5-7 µm, subclavate, 4-spored. **Pleurocystidia** 55-74 x 7-11.5 µm, abundant, fusiform to conical, projected up to 48 µm beyond hymenial layer. **Cheilocystidia** 39-47 x 7-8 µm, clavate to subclavate. **Paracystidia** 26-30 x 8.5-9.5 µm, densely crowded, clavate. Subhymenium narrow, up to 10 µm thick, cellular. **Pileipellis** an ixocutis, about 500 µm thick, composed of densely interwoven thin walled hyphae, hyphae 2.5-4 µm broad. **Lactiferous hyphae** abundant in pilear trama,up to 8 µm broad.

Ecology. Solitary, forming ectomycorrhiza with *Quercus leucotrichophora* A. Camus in temperate deciduous forests of Kumaon Himalaya.

Specimens examined. India, Uttaranchal, Champawat, Abbot Mount, 2200m, on ground, 23.9.2002, KD4524 (Holotype BSD, Isotype GENT); Uttaranchal, Champawat, Furti, 1900m, on ground, 27.9.2002, KD4529 (BSD).

Lactarius abbotanus can easily be recognized in the field by the azonate, glutinous pileus with glutinous marginal hairs, distant lamellae, chalky scrobiculate or pitted stipe and white latex turning brilliant yellow immediately on exposure. Abundant pleurocystidia and fairly thick pileipellis also make this taxon distinct.

The above mentioned characters place this taxon into subgenus *Piperites* (Fr.) Kauff., section *Piperites* Fr. and subsection *Scrobiculati* Hesler & A.H. Sm. It is closely allied with *L. citriolens* Pouzar, *L. delicatus* Burl. and *L. aquizonatus* Kytöv. But unlike the present species, *L. citriolens* (Heilmann-Clausen *et al.* 1998) has dry

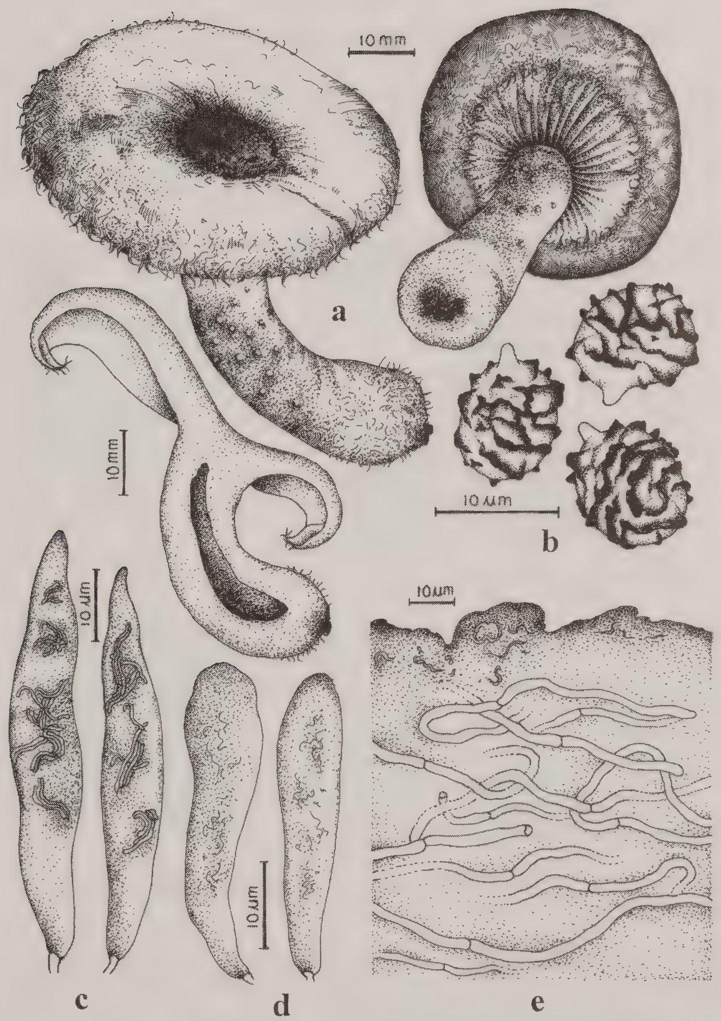
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Fig. 1. *Lactarius abbotanus* (Holotype): a. Basidiomes b. Spores c. Pleurocystidia d. Cheilocystidia e. Cross-section of pileipellis.

marginal hairs, medium crowded lamellae, stipe without scrobicules or pits and smaller spores (6.3-9.1 x 4.7-6.4 µm). Distinctly zonate, glabrescent pileus, faintly to non-scrobiculate stipe and smaller spores (7-9.5 x 6-7 µm) separate *L. delicatus* (Hesler & Smith 1979) from the present taxon. In *L. aquizonatus* (Heilmann-Clausen *et al.* 1998), the pileus is distinctly zonate, gills crowded and spores are smaller (6-8.5 x 4-6 µm).

Lactarius mayawatianus K. Das & J.R. Sharma **sp. nov.** (Fig. 2, 4 d & e).

Pileus 40-75 mm diam., convexus, ad umbelicatus, profunde depressus in centro, luteus. Lamellae moderate densae, decurrentes, luteoalbus. Stipes 40-92 x 9-16 mm, cylindricus. Latex albus, lente pallide galbanus. Sporae 7.5-9.0 x 5.8-7.0 µm, ellipsoidae, amyloidae. Typus: India, Uttaranchal, Champawat, Mayawati, KD4549 (Holotypus BSD; Isotypus GENT).

Etymology. The epithet *mayawatianus* refers to the locality where the type material was collected (Mayawati, Champawat, Uttaranchal, India).

Pileus 40-75 mm diam., at first convex with depressed center, later umbilicate with center deeply depressed, often cracked at maturity; cuticle smooth at center, increasingly hairy towards margin, hairs sometimes confluent to form adpressed triangular scales, viscid, faintly zonate when young, azonate with age, brilliant to light orange yellow, paler at maturity; margin inrolled, hairy when young, forming a roll of cottony tissue almost covering the gap between the edge of margin and the stipe, hairs deep yellowish brown when mature, margin gradually expanding and tomentose to smooth when mature; context yellowish white. **Lamellae** medium crowded (*ca* 7-9 per 10 mm), decurrent, yellowish white, lamellulae in many rows. **Stipe** 40-92 x 9-16 mm, cylindrical or narrower towards base, hollow, non-scrobiculate. **Latex** white, pale greenish yellow (lemon yellow) on exposure. Spore deposit pale yellow.

Spores 7.5-9.0 x 5.8-7.0 µm (n = 20, Q = 1.22-1.38), broadly ellipsoid to ellipsoid, amyloid, ornamentation up to 0.7 µm high, composed mainly of ridges with acute edges forming an incomplete reticulation, few isolated warts present. **Basidia** 33-41 x 6.5-8.5 µm, subclavate, 4-spored. **Pleurocystidia** 53-76 x 9.5-12 µm, fusiform to lanceolate, apex mucronate or sometimes with forked apical appendices, projecting up to 36 µm beyond hymenial layer. **Cheilocystidia** cylindrical to fusiform with acute apices, 44-63 x 8-10 µm. Subhymenial layer up to 10 µm thick, cellular. **Pileipellis** an ixocutis, up to 76 µm thick, mostly composed of parallel hyphae, hyphae thin walled, 2.5-3.5 µm broad. **Lactiferous hyphae** up to 8.5 µm broad, abundant in pilear trama.

Ecology. Gregarious to caespitose, forming ectomycorrhiza with *Rhododendron arboreum* Sm. in temperate Himalayan deciduous forests.

Specimens examined. India, Uttaranchal, Champawat, Mayawati, 2000m, on ground, 28.9.2002, KD4549 (Holotype BSD, Isotype GENT); Uttaranchal, Champawat, Furti, 1900m, on ground, 29.9.2002, KD4551 (BSD); Uttaranchal, Almora, Mornoula, 2100m, on ground, 6.10.2002, KD4582 (BSD).

Lactarius mayawatianus also belongs to subgenus *Piperites*, section *Piperites*, subsection *Scrobiculati*. It is readily recognized by the presence of a roll of cottony tissue at young age, which disappears slowly and the pilear margin becomes glabrescent

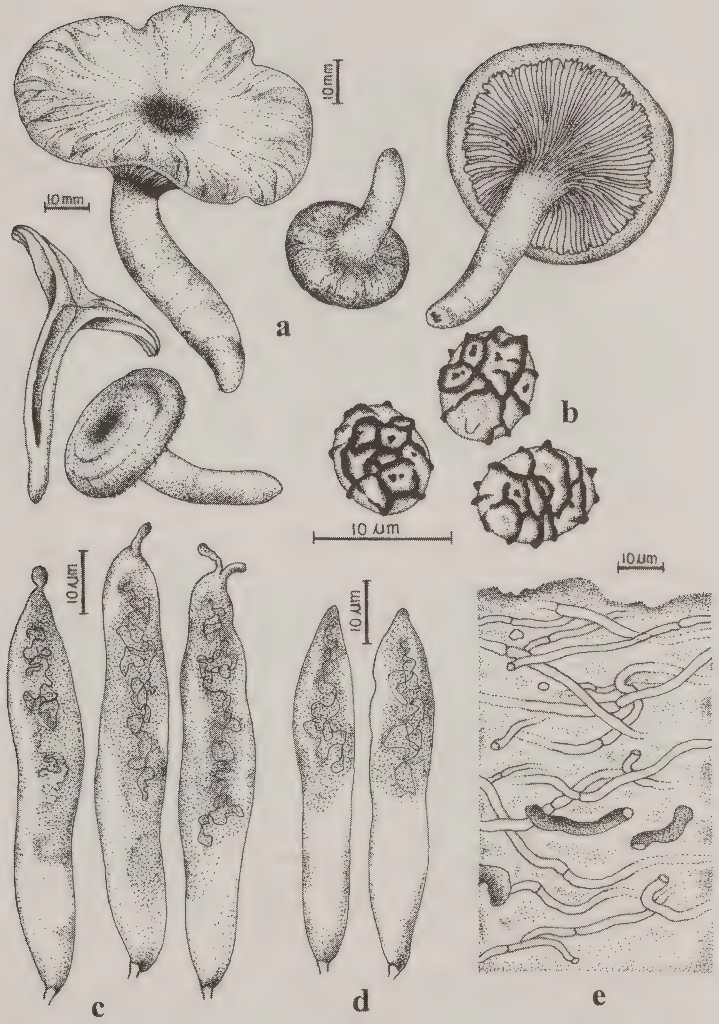
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Fig. 2. *Lactarius mayawatianus* (Holotype): a. Basidiomes b. Spores c. Pleurocystidia d. Cheilocystidia e. Cross-section of pileipellis.

to smooth at maturity, brownish adpressed pilear hairs, crowded lamellae with numerous lamellulae and a non-scrobiculate stipe.

Morphologically *L. mayawatianus* seems to be closely related to *L. gossypinus* Hesler & A.H. Sm. and *L. scrobiculatus* (Scop.:Fr.) Fr. But *L. gossypinus* (Hesler & Smith 1979) can, however, be separated from *L. mayawatianus* by zonate pileus, lamellae with pinkish tinge, watery, unchanging latex, white spore deposit and lower spore ornamentation (up to 0.2 µm high). The basidiomes of *L. scrobiculatus* (Heilmann-Clausen *et al.* 1998) are larger (60-200 mm), intensely yellow with distinctly honey coloured zones, and the above all scrobiculate stipe has irregularly shaped brown pits. Microscopically, the warts and ridges on spores are up to 1 µm high, and the fusoid pleurocystidia are absent or uncommon.

Lactarius subindigo Verbeken & E. Horak. *Australian Systematic Botany* 13: 651, 2000. (Fig. 3, 4 f & g).

Pileus 55-70 mm diam., at first convex with depressed center, later umbilicate when mature; cuticle viscid when moist, zonate, medium greenish to medium blue with silvery lustre, sometimes medium yellow with age; margin strongly incurved when young, plane when mature. **Lamellae** decurrent, crowded (*ca* 10-14 per 10 mm), lamellulae in several rows, very light to medium greenish blue, deep to very deep greenish blue after bruising. **Stipe** 25-40 x 6-10 mm, cylindrical or gradually tapered towards base, concolorous with pileus, scrobiculate, hollow. Context brittle, light greenish to light blue. **Latex** dark to deep greenish blue, unchanging. Spore deposit yellowish white.

Spores 7.00-8.50 x 5.50-7.20 µm (n = 20, Q = 1.18-1.38), broadly ellipsoid to ellipsoid, amyloid, ornamentation up to 0.5 µm high, composed of blunt ridges forming partial to incomplete reticulation, isolated warts abundant. **Basidia** 40-64 x 7-8.5 µm, subclavate, 4-spored. **Pleurocystidia** and **Cheilocystidia** both absent. **Pseudocystidia** abundant, shape irregular, 30-55 x 3-5 µm. Subhymenial layer 12-14 µm thick, cellular. **Pileipellis** an ixocutis, 50-80 µm thick, composed of interwoven hyphae, hyphae up to 3 µm broad. **Lactiferous hyphae** abundant in pilear trama, up to 7 µm broad.

Ecology. Caespitose to gregarious, forming ectomycorrhiza with *Quercus leucotrichophora* in the temperate deciduous and mixed coniferous forests of Kumaon Himalaya.

Specimens examined. India, Uttaranchal, Champawat, Abbot Mount, 2200m, on ground, 24.9.2002, KD4525 (BSD); Uttaranchal, Champawat, Mayawati, 2000m, on ground, 30.9.2002, KD4550 (BSD); Uttaranchal, Almora, Mornoula, 2100m, on ground, 6.10.2002, KD4584 (BSD).

Lactarius subindigo belongs to subgenus *Piperites*, section *Dapetes* Fr. and is quite common in North western Himalaya. It can be identified by overall indigo blue basidiocarps becoming yellow with age, medium blue, viscid and zonate pilear surface with a silvery lustre, bluish latex and scrobiculate, hollow stipe.

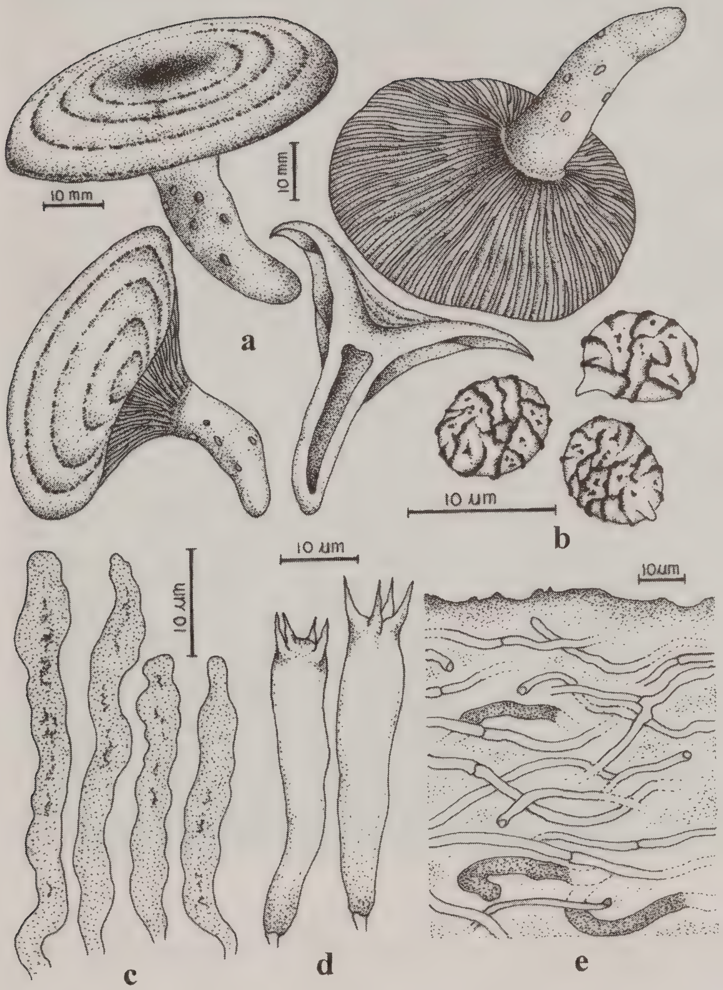
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Fig. 3. *Lactarius subindigo* (KD 4550): a. Basidiomes b. Spores c. Pseudocystidia d. Basidia e. Cross-section of pileipellis.

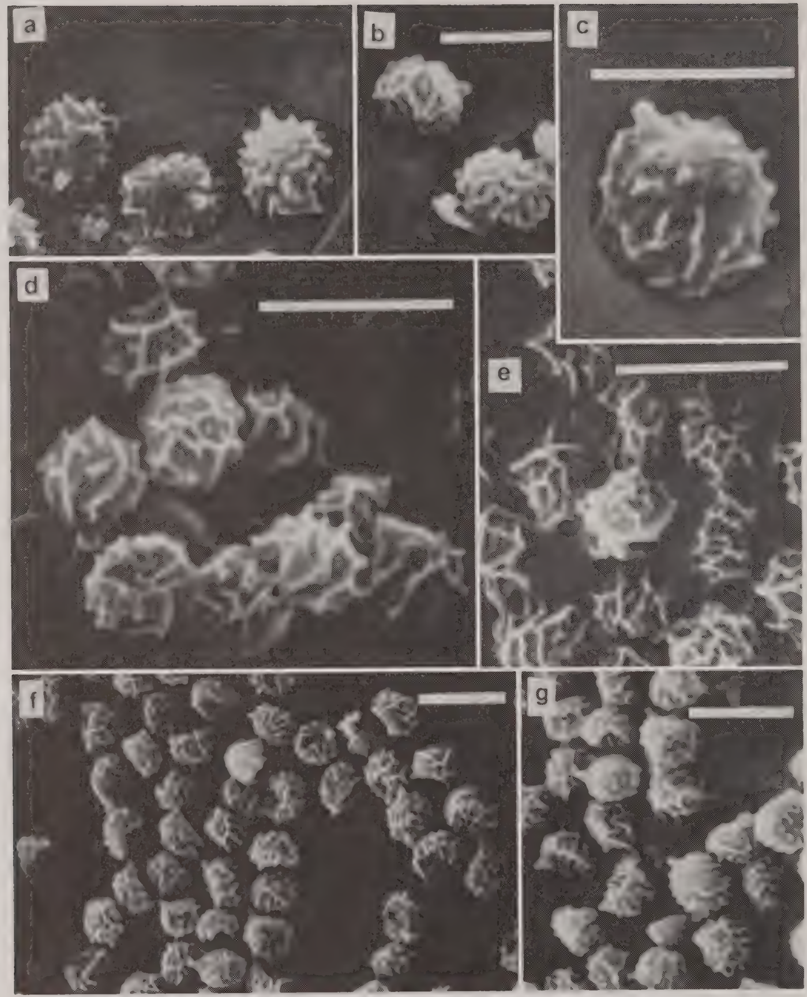

Fig. 4. a-c. Spores under SEM of *Lactarius abbotanus*. d, e. Spores under SEM of *Lactarius mayawatianus*. f, g. Spores under SEM of *Lactarius subindigo*. Bars = 10 µm.

This species is distinguished from the closely related *L. indigo* (Schwein.) Fr. by the absence of true pleurocystidia, cheilocystidia and smaller spores (*ca* 7-9.5 x 6-7.5 µm in *L. indigo*) with wider and more rounded ridges (Verbeken & Horak 2000). The overall bluish appearance *L. subindigo* may also share with *L. quieticolor*. But the pale yellowish pink to light orange lamellae, orange latex turning reddish brown on exposure and true cystidia clearly separate *L. quieticolor* from *L. subindigo*.

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LITERATURE CITED

Das, K. and J.R. Sharma, 2002. The genus *Lactarius* in India. *Bulletin of the Botanical Survey of India* (in press).

Kelly, K.L. and D.B. Judd, 1955. *The ISCC – NBS Method of Designating Colours and A Dictionary of Colour Names, NBS Circular 553.*

Heilmann-Clausen, J., Verbeken, A. and J. Vesterholt, 1998. *The genus Lactarius*. The Danish Mycological Society. 287pp.

Hesler, L.R. and A.H. Smith, 1979. *North American Species of Lactarius*. Univ. Michigan, Ann Arbor. 841pp.

Holmgren, P.K., Holmgren, N.H. and L.C. Barnett, 1990. *Index Herbariorum*: Part 1: Herbaria of the world, 86th ed. Brox: New York Botanical Garden.

Verbeken, A and E. Horak, 2000. *Lactarius* (Basidiomycota) in Papua New Guinea 2. Species in Tropical-montane Rainforests. *Australian Systematic Botany* **13**: 649 – 707.

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A NEW SPECIES OF ALBOTRICHA FROM TAIWAN

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ABSTRACT

A new discomycete from decayed culms of the silvergrass *Miscanthus floridulus* at the volcano area of Yangmingshan National Park, Taiwan is described and illustrated. This new hyaloscyphaceous discomycete, *Albotricha hainesii*, is characterized by whitish apothecia and very small cylindrical to ovoid, usually distinctly biguttulate ascospores.

Key words: Hyaloscyphaceae, taxonomy, *Albotricha hainesii*

INTRODUCTION

The genus *Albotricha* was erected by Raitviir for 6 species with *Peziza acutipila* P. Karst. as type species (Raitviir, 1970). In addition to the original existing British collections (Dennis, 1949, 1963), new species and records of this genus were discovered and reported from many other regions of the world (Raitviir, 1970, 1973, 1981, 1993; Raitviir and Sacconi, 1987; Raitviir and Blank, 1988; Thind and Sharma, 1983; Huhtinen, 1982; Hosoya, 1998; Otani, 1967; Yu, *et al.*, 2000; Zhuang, 1998, 2000). However, there was no record of *Albotricha* from Taiwan (Wang, *et al.*, 1999) although many other hyaloscyphaceous discomycetes, especially the species of *Lachnum* (Wu, 1995; Wu, *et al.*, 1998), had been reported.

The present study is a part of a larger study on the saprotrophic ascomycetes of Taiwan in the northern mountain area. Collections were made once per two months from January 2000 to December 2001. Five sampling plots were constructed in the area of Silvergrass Grasslands near Hsiaoyukeng in Mt. Chichsing of Yangmingshan National Park (YNP), Taiwan. The soil around Hsiaoyukeng area is a thin layer eroded by geothermal warmth and is with high acidity. Only plants such as lichen, mosses, liverworts, and blue-green algae tolerating strong acidity, can survive there. However, silvergrass (*Miscnathus floridulis*, (Labill.) Warb. ex K. Schum. & Laut, Poaceae) which is weathered in warm volcano mist, forms extensive Silvergrass Grasslands. All samples were from this specific ecological area.

Color of the disc and size of the apothecia are based on fresh material. Dried specimens were rehydrated in 3 % KOH before microscopic examination. Measurements were made from material mounted in 3% KOH. Iodine reaction was tested in Melzer's reagent. Terms used to describe the excipular type are from Korf (1973). The hair characters are described following proposals of Hosoya (1998). The specimens cited below were deposited at Herbarium (TNM), National Museum of Natural Science, Taichung, R. O. C. and Herbarium (TMTC), The Department of Science Education of Taipei Municipal Teacher's College.

DESCRIPTION

Albotricha hainesii M. L. Wu sp. nov. (Figs. 1-6)

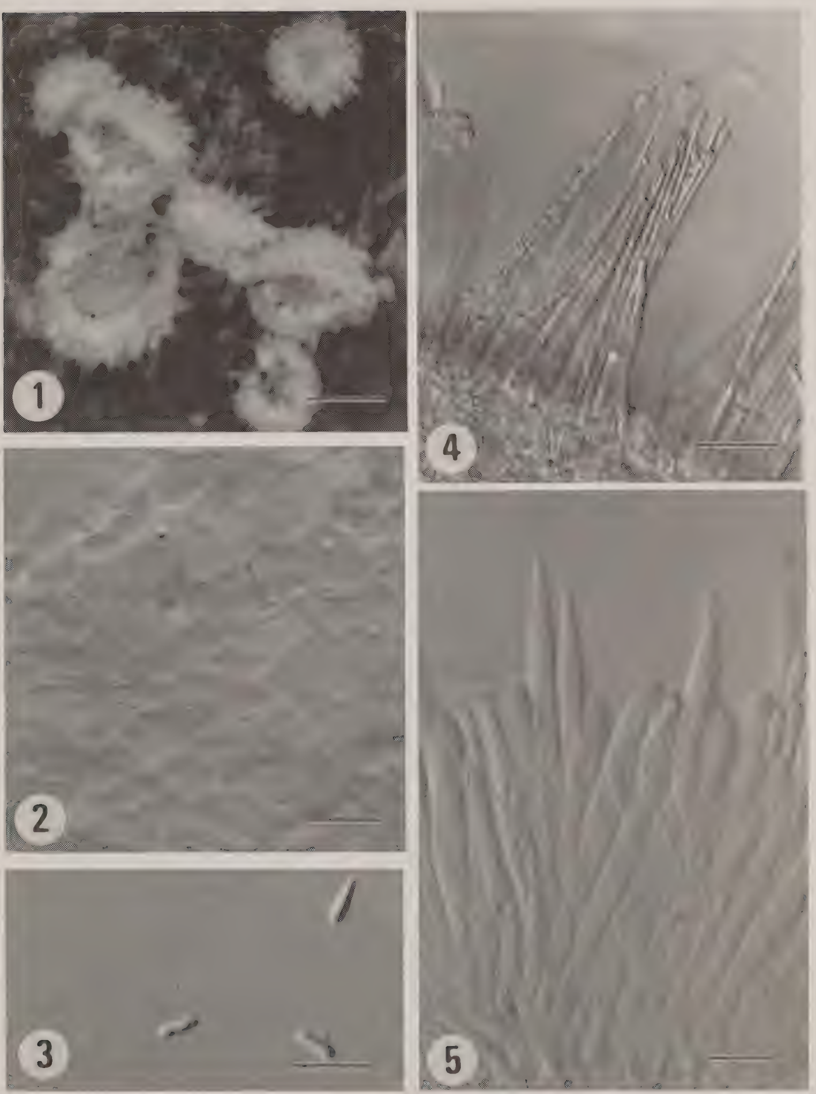
Apothecia dispersa in Miscanthus floridulus, usque ad 1.3 mm in diametro, discoidea, plana vel concava, subsessilia vel breviter stipitata. Excipulum ectale ex textura pristmatica et textura angularis compositum. Pili cylindracei, multiseptati, crasse granulati, gradatium angustati ad apicibus obtusis, deinde prolifici, acuti ad apici, cum resina amorpha incrustati, plerumque 125-138 x 2-5 µm, interdum usque ad 150 µm. Asci non uncinati, cylindraceo-clavati, octospori, 31-48 x 3-4 (-5) µm, poro iodo caerulescentia praediti. Ascosporae unicellulares, hyalinae, typice 2-guttulatae, (4.8-) 5-7 (-8.5) x (1-) 1.2-2.0 -(2.5) µm, subcylindraceae vel ovoideae. Paraphyses lanceolatae, asci usque ad 23 µm superantes, 3-5 µm in diametro.

Apothecia scattered on the stem of *Miscanthus floridulus,* 0.5-1.3 mm diam., disc-shaped, subsessile to short stipitate, 0.2-0.8 mm. Disc white when fresh and orange-yellow after dried, flat to slightly concave, hairs distributed on the margin area of the disc and the receptacle . **Ectal excipulum** of textura prismatica and textura angularis, composed of thick-walled cells, (6-) 9.8-11.8 (-17.6) x (6-) 7.8-9.8 (-10.8) µm; medullary excipulum of textura intricata, hyphae hyaline, mostly 1.5-2.0 µm wide. **Hairs** of two kinds, hyaline. **Primary hairs** cylindrical, gradually narrowed to the obtuse apex, multiseptate, with coarse granules from base to apex, mostly 65-75 µm long. **Secondary hairs** formed by proliferation through primary hairs at the apex to form long gradually tapered apex, multiseptate, up to 150 µm long, mostly 125-138 µm long, (2.0)3.0-5.0 µm wide at base and 1.5-2.5 µm wide at apex, warted near the lower 2/3-4/5 part of the hair, bearing amorphous resinous matter, smooth restricted to the upper 1/3-1/5 portion of the hair. **Asci** 31-48 x 3-4(-5) µm, cylindric clavate, crozier not present at the base, pore J+ when stained with Melzer's reagent. **Ascospores** (4.8-)5-7(-8.5) x (1-)1.2-2.0(-2.5) µm, hyaline, subcylindrical to ovoid, unicellular, usually bearing two distinct large guttules at two ends when mature, occasionally containing 2-3 small guttules near the large one. **Paraphyses** 3-5 µm diam. at the widest point, septate, with an acute tip, exceeding the asci by 18-20(-23) µm.

Holotype: REPUBLIC OF CHINA, Taiwan, Taipei, Yangmingshan National Park, Silvergrass Grasslands, near Hsiaoyukeng Visitor Center, Mt. Chichsing, alt. 800 m, 25°10´ N, 121°32´ E, on culm of *Miscanthus floridulus* (Labill.) Warb. ex K. Schum. & Laut (Poaceae), M. L. Wu, 28-X-2000, *Wu 001028ST17-1,* (TNM); Isotype in (TMTC).

Etymology: From Haines, the last name of Dr. John Haines, in honor for his contributions to the study of hyaloscyphaceous discomycetes.

Other specimens examined: Taipei, Yangmingshan National Park, Silvergrass Grasslands, near Hsiaoyukeng Visitor Center, Mt. Chichsing, alt. 800 m, 25°10´ N, 121°32´ E, on culm of *M. floridulus,* M. L. Wu, 28-X-2000, Wu 001028ST8, Wu 001028ST9; 23-XII-2000, Wu 001223ST4, Wu 001223ST9, Wu 001223ST10, Wu 001223ST13; 20-II-2001, Wu 010220ST2, Wu 010220ST4 and Wu 010220ST16.



Figs.1-5. *Albotricha hainesii*. 1. Dry apothecia. Bar = 0.25 mm. 2. Ectal excipulum. Bar = 10 µm. 3. Ascospores. Bar = 10 µm. 4. Hairs at margin of the disc. Note smooth to slightly roughened septate hairs. Bar = 25 µm. 5. Hymenium with lanceolate paraphyses and asci. Bar = 8 µm. (Figs. 2-5 Normaski microscopy.)

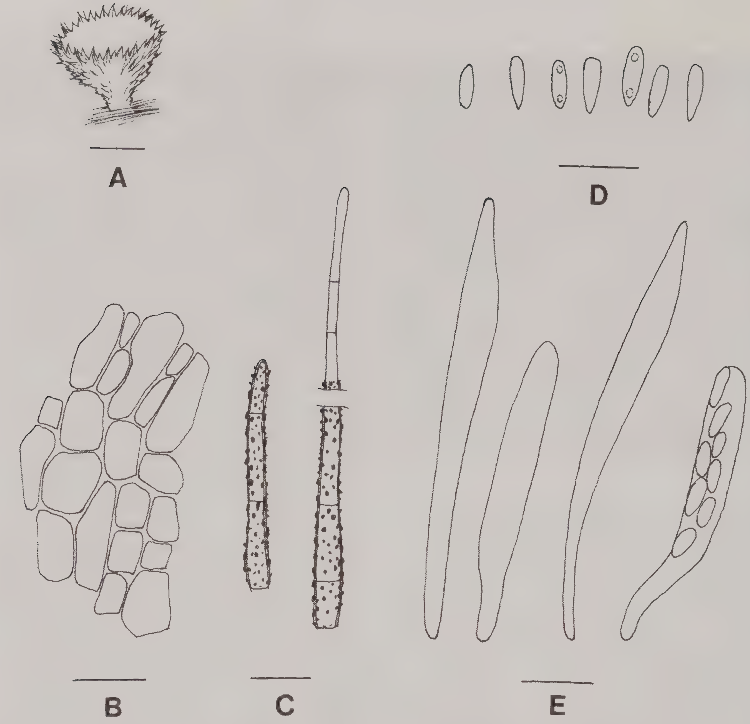


Fig. 6. *Albotricha hainesii*. A. Apothecia. B. Ectal excipulum. C. Primary hair (left) and secondary hair (right). D. Ascospores. E. Paraphyses and asci. Bar A = 0.5 mm; Bars: B, C, D, E = 10 µm. From HOLOTYPE.

DISCUSSION

Albotricha was segregated from *Lachnum* by Raitviir (1970). Recently some authors didn't think the necessity of segregating *Albotricha* from *Lachnum* therefore the genus *Albotricha* is not currently in use by some authors (Hawksworth, *et al.*, 1995). According to the CABI Bioscience and CBS Database of Fungal Names, there were about ten combinations of *Lachnum* species from the genus *Albotricha*. However, Leenurm, *et al.* (1999) studied the ultrastructure of *Lachnum* and related genera and found that clear intergeneric differences in the hair wall structure between the studied genera including *Albotricha* and *Lachnum*. They concluded that both hair and ascal ultrastructural features support the narrow genus concept in the group of *Lachnum* and its segregates (Leenurm *et al.*, 1999). But *Albotricha andina* (Pat.) Raitv. was placed in genus *Hegermila* Raitv. by Rativiir (1995) according to his further study in the species of Trichopezizelloideae, and the genus *Albotricha* contains about 23 published species and characterized by the presence of aciculate, smooth to slightly roughened septate hairs and lanceolate paraphyses.

Although there are already a number of *Albotricha* described from Asia, (Raitviir, 1981, 1993; Thind and Sharma, 1983; Zhuang, 2000; Huhtinen, 1982; Hosoya, 1998; Otani, 1967; Yu, *et al.*, 2000) the present species appears to be new. *Albotricha hainesii* differs from all known specices in its small cylindrical to ovoid spores with two distinct large guttules and specific substrate. All specimens of the *Albotricha hainesii* discovered from Taiwan were collected from *M. floridulus* (Poaceae) at the volcano area with specific environmental conditions.

Albotricha acutipila (Karst.) Raitv., *A. alpina* (Rehm) Raitv. & Sacconi, *A. caduca* (Rehm) Raitv. & Sacconi and *A. albotastacea* (Desm.) Dennis are all from grass (Dennis, 1949, Raitviir, 1970, 1973, 1981) but with larger spores (usually larger than 8 μm). In addition to *A. kurilensis* Raitv. (Zhuang, 2000; Raitviir, 1981), *A. andina* (Pat.) Raitv., *A. laetior* (Karst.) Raitv., *A. kamtschatica* (Raitv.) Raitv. (synonym *A. orientalis* Raitv.), *A. orientalis* var. *sacchalinensis* Raitv., *A. pallida* Raitv., *A. vantschensis* Raitv. were all from herbaceous stem (Raitviir, 1970) and with ascospores (> 8 μm) larger than *A. hainesii* (4.8-8.5 x 1-2.5 μm). *Albotricha hainesii* has a white hymenium and small ascospores (5-8 x 1.0-2.5 μm) similar to *A. washingtonensis* (Dennis) Raitv. (5-7 x 0.5-1 μm) (Raitiviir, 1970) but they differ in the width of ascospores (1.0-2.5 μm vs. 0.5-1 μm), size of apothecia (0.3-1.5mm vs. 0.3 mm), asci (31-48 x 3-5 μm vs. 33 x 5 μm) and substrate (grass vs. fern). The size of spores (4.5-7.5 μm x 1.5-2 μm) and asci (34-43 μm x 4-4.5 μm) of *A. fagicola* Hosoya (Hosoya, 1998) are similar to *A. hainesi*. However, *A. fagicola* is foliicolous and has small apothecia (500 μm diam.) with light orange hymenium while *A. hainesii* is from grass and has a larger apothecia (0.5-1.3 mm diam.) with white hymenium. *Albotricha miniata* (Kanouse) Raitv. subsp. *schoenoplecti* Raitv. & Blank has similar size of ascospores but its asci are smaller than those of *A. hainesii* (20-28 x 4 μm vs. 31-48 x 3-6 μm).

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REFERENCES

Dennis, R. W. G. 1949. A revision of the British Hyaloscyphaceae, with notes on related European species. Mycol. Pap. **32**: 1-97.

Dennis, R. W. G. 1963. A redisposition of some fungi ascribed to the Hyaloscyphaceae. Kew Bull. **17**: 319-379.

Hawksworth, D. L., P. M. Kirk, B. C. Sutton and D. N. Pegler. 1995. Ainsworth & Bisby's Dictionary of the Fungi. International Mycological Institute.

Hosoya, T. 1998. Floristic and taxonomy studies on the family Hyaloscyphaceae (Leotiales, Discomycetes) in Japan. Ph. D. thesis in Biological Science, University of Tsukuba.

Huhtinen, S. 1982. Ascomycetes from central and northern Labrador. Karstenia, **22 :** 1-8.

Korf, R. P. 1973. Discomycetes and Tuberales. Pp. 247-319. In: The fungi, an advanced treaties. Vol IVA. Eds. G. S. Ainsworth, F. K. Sparrow, and A. S. Sussman. Academic Press, New York.

Leenurm, K., A. Raitviir, and R. Raid. 2000. Studies on the ultrastructure of *Lachnum* and related genera. (Hyaloscyphaceae, Helotiales, Ascomycetes). Sydowia **52:** 30-45.

Otani, Y. 1967. Note on some cup fungi of the Hyaloscyphaceae collected in Hokkaido, Japan. Trans. Mycol. Soc. Japan **8:** 33-42.

Raitviir, A. 1970. Synopsis of the Hyaloscyphaceae. Scripta Mycol. **1:**1-115.

Raitviir, A. and S. Sacconi. 1987. Some interesting Hyaloscyphaceae from north Italy. Mycologia Helvetica **2:** 165-171.

Raitviir, A. 1973. Some new species of *Albotricha*. Fol. Crypt. Est. Fasc. **2:** 13-15.

Raitviir, A. 1981. New species of the Hyaloscyphaceae from the middle Asia. Fol. Crypt. Est. Fasc. **12:**1-8.

Raitviir, A. and P. Blank. 1988. Zwei neue Hyaloscyphaceae auf Schoenoplectus lacustris. Mycologia Helvetica **3:** 143-148.

Raitviir, A. 1993. List of alpine and subalpine Hyaloscyphaceeae from central Asia. Arctic and alpine Mycology 3. Bibl. Mycol. **150:** 201-214.

Raitviir, A. and Helle Jarv. 1995. Studies in the Trichopezizelloideae (Hyaloscyphaceae, discomycetes) Proc. Estonian Acad. Sci. Biol., **1/2 :** 23-31.

Thind, K. S. and Sharma, M. P. 1983. The Nepal Helotiales-I. Bibl. Mycol. **91:** 265-279.

Wang, Y. Z., S. H. Wu, Y. N. Chou, T. T. Chang, K. Y. Chen, S. F. Chen, J. L. Chen, S. S. Tzean, C. H. Liu, W. H. Hsieh, H. J. Hsieh, C. H. Chung and C. Y. Chien. 1999. List of the fungi in Taiwan. The Council of Agriculture of the Executive Yuan of the R. O. C. 289 pp.

Wu, M. L. 1995. Studies on the saprophytic ascomycetes from northern mountain area of Taiwan. I-Shan Pub. Co. 75 pp.

Wu, M. L., J. H. Haines and Y. Z. Wang. 1998. New species and records of *Lachnum* from Taiwan. Mycotaxon **67:** 341-354.

Yu, Z. H., W. Y. Zhuang, S. I. Chen and C. Decock. 2000. Preliminary survey of discomycetes from the Changbai Mountains, China. Mycotaxon **75:**395-408.

Zhuang, W. Y. 1998. Discomycetes of Tropical China. III Hyaloscyphaceous fungi from tropical Guangxi. Mycotaxon **69:** 359-376.

Zhuang, W. Y. 2000. Hyaloscyphaceous discomycetes from Ningxia Province, China. Mycologia **92**: 593-597.

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ON C. G. MOSIG'S LICHEN HERBARIUM, WITH EMPHASIS ON TYPE MATERIAL OF LICHENS AND FUNGI

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ABSTRACT

In 1810 Acharius based many descriptions of lichen taxa on material collected by C. G. Mosig. Mosig's herbarium in GLM contains probable isotypes. In contrast to the specimens in Acharius' herbaria, the collecting sites, most of which belong to Poland today, are given in detail in Mosig's herbarium. There are also possible types of fungi described as lichens by Acharius and not yet typified. Furthermore, Mosig's lichen collection contains several syntypes from Flörke's exsiccatae set and many reference specimens received from other lichenologists of the late 18th/early 19th century, with a considerable number of at least possible types among them; that might be the case also in a number of fungi. Not all of the corresponding taxa have as yet been typified.

Key words: early lichenology, type specimens

ON MOSIG AND HIS COLLECTIONS

One of the collectors mentioned most frequently in the fundamental „Lichenographia Universalis" of Acharius (1810) was Carl Gottlob Mosig (1758-1832), court director in Meffersdorf in the Isergebirge Mts., at that time belonging to Upper Lusatia (Oberlausitz) province of the state of Saxony (Germany). In many cases descriptions of species by Acharius (1810) are based on material received from Mosig. In this way Mosig, although having never described any species himself, became an important person for early lichenology. Schade (1966) reported the re-discovery of Mosig's lichen herbarium, which is now kept in Görlitz (GLM), and the possible presence of type material in it. Schade, however, who was already more than 80 years old at that time, could not deal with the material more intensively. His paper on "an old Upper Lusatian lichen herbarium" seems not to have found wide consideration and Mosig's herbarium has thus remained widely unknown to taxonomists until today. It therefore seems useful to present more detailed information concerning it.

General reports were given by Schade (1966) and Otte (2002); here the type material in particular is considered.

COMPOSITION OF MOSIG'S HERBARIUM, WITH SPECIAL REFERENCE TO TYPE MATERIAL

Generally the specimens in Mosig's herbarium can be divided into two groups: material collected by Mosig himself and that received from other persons. It can be concluded from Mosig's herbarium that he corresponded at least with G. F. Hoffmann, H. A. Schrader, E. Acharius, J. Ch. Schleicher, H. G. Flörke, Ch. H. Persoon and one American lichenologist. Partly he sent material to them for determination; partly he received material from them for reference. In both groups of material, possible type material can be detected.

Mosig's own collections

Mosig's collections served as the basis of descriptions of taxa by Acharius (1810). In more than 20 cases Acharius refers in his protologues singly to material collected by Mosig, in about 20 other cases to Mosig's among other material. According to Vitikainen (in litt.), all lichen species described on the basis of Mosig's collections are represented by specimens in the Acharian herbarium H-ACH in Helsinki. These specimens must therefore be considered as the holotypes. However, in most cases it is evident that a part of the collected material was preserved also by Mosig. Mosig evidently gave a number to the material, sent a part of it to Acharius (or other authorities) and named his material after having received a reply from Acharius (or the other authorities) – among it material not merely determined by Acharius, but used by him for descriptions of new taxa. That can be concluded from some loose notes in Mosig's herbarium with texts as "ad Achar. 10." (or "Nr. 33 ad Schrad." or "Nr. 61 ad Flörke", respectively). Unfortunately, these notes, of which only very few are preserved, are, as a consequence of further work with the herbarium, not any more connected with specimens. Thus it is not possible to identify the probable type material as isotypes of the holotypes in H with certainty. Nevertheless, this identity is very likely in many instances (in single cases documented by detailed indication of the collecting sites by Acharius 1810, which are the same as in the corresponding Mosig specimens in GLM: e. g. *Lecidea arthonioides* Ach., *Verrucaria laevata* Ach., *Lecanora atra* var. *accumulata* Ach.).

That is important not only in view of the existence of the probable isotypes itself (of which several are rather welcome due to the poor state of the holotypes in H) but also because of the usually detailed indication of the collecting localities on Mosig's notes. In Acharius' herbarium, as a rule, merely "Lusatia, Mosig" is noted (Vitikainen in litt.; see e. g. Tibell 1987), and in Acharius (1810) most localities are also imprecise (exceptions see above). Only Mosig's herbarium enables localisation of the probable type localities of many species. Most of these are situated in the vicinity of Mosig's home village Meffersdorf (Unięcice). It should be noted that this area in the Isergebirge Mts. (Góry Izerskie) now belongs to Poland, and so do the probable type localities of a number of species, including those presumed to be located in Saxony (Germany) by some authors, based on the poor data in herb. Acharius.

That is also the situation in *Pyrenula gibbosa* Ach. (= *Rimularia gibbosa* (Ach.) Coppins, Hertel & Rambold), which is mentioned from mount "Hochstein Lusatiae" by Acharius (1810). There are two mountains named "Hochstein" in the former province of Upper Lusatia, and Mosig collected lichens at both. Mosig's herbarium shows that *Rimularia gibbosa* was collected at Mt. Hochstein in Isergebirge Mts. (today in Poland), and not at Mt. Hochstein near Görlitz (Germany) as thought e.g. by Rabenhorst (1840) and other authors after him.

In contrast to the abovementioned presence of type material of the species in H, material of some fungi described by Acharius (1810) as lichens could not be detected in Herb. Acharius (Vitikainen in litt.). It is, however, available in Herb. Mosig and could serve for lectotypification. That is the case in *Spiloma paradoxum* Ach., where the material in Mosig's herbarium is likely to be the only preserved type material and in *Calicium cladoniscum* Ach., the description of which was based on both material of Mosig and Schleicher, and where only in UPS (undeterminable) material could be traced (Tibell 1987)[1].

Reference material sent by other persons

Schleicher, Hoffmann and Schrader specimens

A large collection originates from J. Ch. Schleicher in Switzerland, another collector upon whose material many descriptions by Acharius (1810) were based. The Schleicher material could represent type material for more than 20 Acharian taxa based on Schleicher's material alone and furthermore for over 20 taxa based on Schleicher's and other material. Since the origin is only indicated as "ex Helvetia auct. Schleicheri" (and similarly inadequate in Herb. Acharius and mostly also in Acharius 1810), these specimens have to be considered as possible types.

Some material with Hoffmann's authorship of species names was authorised by Hoffmann himself or by Schrader. The latter, who was in Göttingen together with Hoffmann and following him (see Grummann 1974, Wagenitz 1982), probably had good knowledge of Hoffmann's species and perhaps even possessed type material of Hoffmann. That is important because of the often occurring difficulties in typification of Hoffmann's lichen names (see e. g. Flörke 1809, Jørgensen 1978). The authorised Hoffmann and Schrader material in herb. Mosig can help to understand Hoffmann's species concepts and be a source of type material although it partly doesn't match very well with Hoffmann's protologues (as already criticised by Flörke 1809 for other Hoffmann material) or is in poor condition.

Possible Acharian and Flörke specimens

It is rather striking that there are no specimens marked as originating from Acharius, although most of the exsiccata are named according to Acharius' nomenclature, and Mosig himself sent a considerable number of specimens to Acharius for determination. But also in material collected by Mosig and determined or described by Acharius, this authority (except as author of the name) is named almost only in very special cases as the determiner of the specimen: when there are remarks to the material (additions to the names referring to modifications) or when it couldn't be clearly identified (in the mode: "A Celeb. Achario sic determinata: Lecideae cyrtellae simillima. Si lichenis vera species, a Lecid. cyrtella vix distingui potest").

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[1] It is very striking that in this species, besides the Lusatian material collected by Mosig, material without indication of its source with the incorrect name „*Calicium cladonellum*" is present, as was found also in UPS by Tibell (1987).

There is, however, a large number of specimens without any indication of origin, with Acharius as author of the name, among them exotic species that must have been sent to Mosig by another person. It seems not improbable that it is original Acharian material. The schedae of these specimens were re-written by Schroeter, the man who (without having lichenological knowledge himself) sorted and ordered Mosig's herbarium after it had come to the Upper Lusatian Society of Sciences in 1829. The original schedae are unfortunately lost, so that the origin of these specimens cannot be proved by them any more. Thus, although many of these specimens probably represent possible types, their status is problematical.

In some older specimens, with "*Lichen*" as generic name, schedae (written in Mosig's handwriting) with origin indicated as "aus Schweden" (from Sweden) could refer to Acharius as source of the material.

In two specimens a third, yet unidentified, handwriting occurs, the identification of which could possibly clarify the origin of these specimens.

In analogy to the above, some specimens with Flörke as author name, without any further information, could represent original material from Flörke. Such should be less assumed in material with Hoffmann's names (without further information), because specimens of Hoffmann species had been distributed by several authors at that time (see Lynge 1915); although the large exsiccatae sets of Ehrhart, Funck and Schrader seem not to have been included in Mosig's herbarium (see below).

American specimens

14 specimens (of species occurring in America) are labelled with "L. v. S." as author name and often "Salem" as collecting site, one with "Salem" only. It is evident that "L. v. S." is the American mycologist and lichenologist Lewis von Schweinitz, who lived in Salem, North Carolina. A part of these names was validly published by Halsey (1824), with reference to a manuscript of v. Schweinitz. According to Zahlbruckner (1922-1940), apparently not all of these names have been typified and used further in American lichenology. Another part of these names seems to have not been published. The source of these specimens could not hitherto be stated although it is not improbable that they were sent by v. Schweinitz himself. Schweinitz spent some years in Upper Lusatia before returning to America (see Albertini & Schweinitz 1805) and it is well possible that he already came into contact with Mosig at that time.

At any rate, there are not only specimens with v. Schweinitz' authorship among the American material. There is also "*Cornicularia fibrillosa*" (without author name), a name misapplied by Halsey (1824) as an Acharian name. As in the lectotype (see Brodo & Hawksworth 1977), the material represents *Bryoria furcellata* (Fr.) Brodo & D.Hawksw. Furthermore, there is "*Pyrenula enteroleuca* Sprengel" (validly published by Halsey 1824, see Zahlbruckner 1922-1940) and specimens of two American species published by C. P. J. Sprengel. Doubtlessly, a high proportion of all these specimens represents possible type material. Perhaps a specimen that is now lost, with "Nobson" as author name, mentioned in Schroeter's herbaria catalogue of 1829, also belonged to this group of specimens.

Exsiccatae sets

Mosig's herbarium contains nearly completely the first three fascicles of Flörke's "Deutsche Lichenen" (1815) and thus the syntypes occurring among them.

It seems that the lichens of Ludwig's cryptogamic exsiccata from Riesengebirge Mts. (see Lynge 1915) are among the Mosig material and possibly Schade (1966) is right that Mosig was the collector of them (C. Ludwig, known as a bryologist, also lived in Meffersdorf). Type specimens seem not to be among them.

Only few coincidences of material of unknown origin in Mosig's herbarium with taxa distributed by specimens in the exsiccatae sets of Ehrhart, Funck and Schrader (according to Lynge 1915) can be stated, so that these sets evidently are not included in Mosig's herbarium.

Lost specimens

A comparison with the catalogue of Mosig's herbarium written in 1829 by Schroeter (see Otte 2002) shows that in the meantime only few losses have taken place. However, some "*Lecidea*" specimens have disappeared, among them probable type material from the group of American specimens mentioned above. It is unclear at present, if the missing specimens might be among the mixed material without any schedae, which is in the herbarium (see Schade 1966).

See also chapter "fungi".

Fungi

There are some dozens of specimens of fungi in the herbarium. Nearly all of them have no indication of the collecting site and a considerable number also lacks an author name. Perhaps it predominantly represents comparison material received from other persons; it cannot be estimated as yet whether possible types could be among it. Some specimens were either sent or determined by Persoon, as indicated by notes such as "auct. Persoonis" or "Thelephora cel. Pers. ignota". Also the names without author name are chiefly those created by Persoon (Kummer in litt.). In one case a collecting site in Meffersdorf is given, which could indicate Mosig himself as the collector (or Oettel, or Ludwig). In addition to Mosig's and Schroeter's handwritings, there are two still unidentified handwritings.

Compared with the catalogue of 1829, all 26 "*Peziza*" specimens and *Dematium abietinum* Pers. are lost.

Other systematic groups

The origin of the bryophytes in the herbarium is still unclear (see Schade 1966). The handwriting on the envelopes is that of Schroeter. Furthermore, there are very few algae of the genus "*Byssus*".

OTHER HERBARIA WITH MOSIG SPECIMENS

Mosig exchanged material with other lichenologists. Thus it should be expected that Mosig specimens, among them type material, have also been preserved there. In fact, this is the case in the Acharian herbaria in H (holo- and lectotypes, Vitikainen in litt.) and BM (see e. g. Tibell 1987).

Flörke's herbaria, unfortunately, have not been saved (Grummann 1974).

According to Seaward (1984), in WRSL Mosig (and Ludwig) specimens are kept. So far it was not possible to the author to make use of them.

It should be worthwhile to look for Mosig specimens in the herbaria of Schleicher, Hoffmann, Schrader, Persoon, the older American lichenologists and perhaps C. P. J. Sprengel.

It seems that also J. v. Flotow had a number of Mosig specimens and knowledge of the collecting sites of material that is not adequately indicated in Mosig's herbarium (see Körber 1855). Unfortunately, also v. Flotow's herbarium was destroyed (Grummann 1974).

The compact group of all 26 "*Peziza*" specimens from Mosig's herbarium, now lost, was probably given away after 1829 and perhaps could be found somewhere.

The author would be grateful for any information on Mosig specimens in other herbaria.

MOSIG LITERATURE

A manuscript on Upper Lusatian flora written by Mosig that was used by Schrader (see Schrader 1806) and that could give some more information on Mosig's activities, unfortunately until today could not be found (University library of Göttingen, in litt.).

A manuscript on Upper Lusatian flora written by Oettel (who was with Mosig in Meffersdorf, see Schade 1966) at the beginning of the 19th century, which has been preserved in the Upper Lusatian Library of Sciences, mentions a number of lichens found by Mosig in the Isergebirge Mts.

Körber (1855) refers to specimens collected by Mosig and seen by v. Flotow.

For detailed biographic information concerning Mosig see Schade (1966), for Mosig handwriting samples Schade (1966) and Otte (2002).

CATALOGUE OF THE COLLECTION

The catalogue of Mosig's herbarium will be made available via Internet on the sites of Staatliches Museum für Naturkunde Görlitz.

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The author wants to express his thanks to Dr. O. Vitikainen (Helsinki) for kind information on Mosig specimens in H, to Dr. V. Kummer (Potsdam) for research on fungal names occurring on Mosig's herbarium schedae, to the University library of Göttingen for search for the Mosig manuscript used by Schrader, to the Upper Lusatian Library of Sciences in Görlitz for kind support and to H. Boyle (Görlitz) for improving the English of this paper.

REFERENCES

Acharius, E. (1810): Lichenographia universalis. Gottingiae.

Albertini, I. B. de & Schweinitz, L. D. de (1805): Conspectus fungorum in Lusatiae superioris agro Niskiensi crescentium e methodo Persooniana. Lipsiae.

Brodo, I. M. & Hawksworth, D. L. (1977): Alectoria and allied genera in North America. – Opera Bot. 42: 1-164.

Flörke, G. (1809): Correspondenz-Nachrichten. 1. von Herrn Floerke. – Neues J. Bot. 3: 212-218.

Grummann, V. (1974): Biographisch-bibliographisches Handbuch der Lichenologie. Lehre.

Halsey, A. (1824): Synoptical view of the lichens growing in the vicinity of the city of New-York. – Ann. Lyceum Nat. Hist. New-York 1 (1): 3-21.

Jørgensen, P. M. (1978): The lichen family Pannariaceae in Europe. – Opera Bot. 45: 1-123.

Körber, G. W. (1855): Systema Lichenum Germaniae. Breslau.

Lynge, B. (1915): Index specierum et varietatum lichenum quae collectionibus „Lichenes exsiccati“ distributae sunt. Kristiania.

Otte, V. (2002): Das Flechtenherbar von Carl Gottlob Mosig im Staatlichen Museum für Naturkunde Görlitz. – Przyr. Sudet. Zachod. 5: 93-96.

Rabenhorst, L. (1840): Flora Lusatica oder Verzeichniss und Beschreibung der in der Ober- und Niederlausitz wildwachsenden und häufig cultivierten Pflanzen. Zweiter Band. Kryptogamen. Leipzig.

Schade, A. (1966): Ein wertvolles Oberlausitzer Flechten- und Moosherbar aus der Zeit um 1800 im Zusammenhang mit der zeitgenössischen Kryptogamenforschung. – Abh. Ber. Naturkundemus. Görlitz 41 (11): XI/1-XI/22.

Schrader, H. A. (1806): Flora Germanica. Gottingiae.

Seaward, M. R. D. (1984): Lichen herbarium of Wrocław University. Acta Univ. Wratisl. 666, Prace Bot. 29: 149-162.

Tibell, L. (1987): Typification of names of infrageneric taxa described by Acharius and placed by him in Caliciales. – Ann. Bot. Fenn. 24: 257-280.

Wagenitz, G. (1982): Index collectorum principalium Herbarii Gottingensis. Göttingen.

Zahlbruckner, A. (1922-1940): Catalogus lichenum universalis. I-X. Berlin.

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INOCYBE ANGUSTISPORA, I. TAEDOPHILA, AND CORTINARIUS AUREIFOLIUS: AN UNUSUAL INOCYBOID CORTINARIUS

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ABSTRACT

Both *Inocybe angustispora* and *I. taedophila* are taxonomic synonyms of *Cortinarius aureifolius*, a species found in sandy soils under *Pinus* in both eastern and western North America. RPB1 and RPB2 nucleotide sequences of the holotype of *I. angustispora* support a close phylogenetic relationship between this species and *Cortinarius croceus* of subgenus *Dermocybe*, also evident by the shared presence of interhyphal pigment deposits. A taxonomic description, illustrations, and gene phylogenies are presented.

Key words: Agaricales, phylogeny, RPB1, RPB2, taxonomy

INTRODUCTION

Taxonomic confusion has surrounded the identity of *Cortinarius aureifolius* Peck for more than a half century in North America and Europe with many workers misapplying the name, generally to other species of *Cortinarius* Fr. (Ammirati & Gilliam, 1975). Microscopically, this species is unusual in *Cortinarius* because of the brownish yellowish, smooth basidiospores when viewed under the light microscope. When the fibrillose pileus is considered in combination with the unusual spore characters, it is not surprising that some authors have interpreted *C. aureifolius* as a species of *Inocybe* (Fr.) Fr. Indeed, in his protologue, Peck (1885) emphasizes the similarity of *C. aureifolius* to some species of *Inocybe*.

As part of a systematic study of the genus *Inocybe* (Matheny, 2003), type materials of two purported species of *Inocybe* described by Murrill (1944) and, more recently, Bessette and Fatto (1998) were evaluated. In order to abate taxonomic confusion over *C. aureifolius*, a description, including illustrations, of *I. angustispora* and *I. taedophila* are presented. In addition, RPB1 and RPB2 gene phylogenies (Matheny, 2003) of *I. angustispora* are presented to test the relationship of this species to *Inocybe* and *Cortinarius*.

METHODS AND MATERIALS

Sections of dried basidiomata were rehydrated in 3% KOH or in water and then transferred to Melzer's solution. Basidiospore length and width and Q value (ratio of spore length to width) are presented in a range where the lowest and highest 5% of that range are placed in parentheses. Means of these values are italicized. The number (*n*) of spores measured per collection is also indicated by a slash. The Munsell Soil Color Charts (1954) and Ridgway (1912) were consulted for color comparisons of spores and tissues under the microscope.

Collections used in this study are provided in the appendix. DNA extraction, polymerase chain reaction (PCR), and sequencing protocols for RPB1 and RPB2, including cloning, follow that of Matheny et al. (2002) and Matheny (2003). These two genes encode the largest and second largest subunits of RNA polymerase II, respectively and have been shown to be appropriate for phylogenetic studies of agaric fungi (Matheny, 2003). Conserved domains A to C, or portions thereof, of RPB1 (Matheny et al., 2002) and 6 to 7 of RPB2 (Liu, Whelen, & Hall, 1999) were sequenced.

DNA sequences were aligned using Clustal X (Thompson et al., 1997). Alignments are available from the author by request or from TreeBASE (S942). 16 RPB1 and 21 RPB2 accessions in subgenus *Mallocybe* Kuyp. of *Inocybe* were deleted from the data sets prior to the anlaysis. The more inclusive alignments were used in Matheny (2003). The remaining 9 RPB1 and 11 RPB2 accesions included exemplars of subgenus *Mallocybe*, *Crepidotus* (Fr.) Quél., *Phaeomarasmius* Scherffel, *Flammulaster* Earle, *Protoglossum* Massee, and *Cortinarius* Fr. to test the phylogenetic placement for the holotype of *I. angustispora*. These sequences are available on GenBank as AF389551, AY349177, and AY333301-AY333319.

PAUP* (Swofford, 2003) was used to analyze RPB1 and RPB2 sequences separately under the maximum parsimony (MP) criterion. Branch and bound searches were conducted for both data sets using the "furthest" addition sequence. 100 bootstrap replicates (Felsenstein, 1985) under the same branch and bound conditions were done to estimate branch support.

TAXONOMY

***Cortinarius aureifolius* Peck, Ann. Rep. N. Y. St. Mus. 38: 89. 1885. Figs. 1 a-c; 2.**

Inocybe taedophila Murrill, Proc. Flordia Acad. Sci. 7: 122. 1944.
Cortinarius psammophilus Ammirati & A. H. Sm., Mich. Bot. 8: 178. 1969.—*Cortinarius aureifolius* var. *psammophilus* (Ammirati & A. H. Sm.) Ammirati, Syd. Bei. Nova Hedw. 51: 47. 1975.
Dermocybe aureifolia (Peck) M. M. Moser, Schweiz. Z. Pilzk. 52: 100. 1974.
Inocybe angustispora Bessette & Fatto, Mycotaxon 66: 123. 1998.

Pileus 1.0-5.0 cm diam, convex to broadly convex and then nearly plane, not umbonate but at times shallowly depressed at center; margin incurved at first, later decurved, even, not rimulose; surface dry, sericeous-smooth to appressed-fibrillose towards the margin, violaceous fuscous then quickly mahogany red after application of KOH or NH_4OH (dried tissue conspicuously releases reddish pigment in 3% KOH); ochraceous tawny to ochraceous brown or olive brown, typically with grayish brown to fuscous tints over the disc; context very thin, whitish to pale yellow, unchanging when exposed, odor and taste not distinctive or like radishes. Lamellae adnate with decurrent tooth to sinuate, seceding in age; subdistant, with 3-4 tiers of lamellulae; narrow becoming ventricose; pale yellow to greenish yellow at first, becoming dull yellow and finally dull yellowish brown, drying rusty brown, edges pallid-fimbriate when young. Stipe 2.0-5.0 cm X 1.5-6 mm, equal or with slightly enlarged base; partial veil sparse, yellowish, evanescent; surface dry, fibrillose; pale yellow at first becoming dull ochraceous to dull ochraceous tawny; solid becoming hollow.

Basidiospores (9.0-) 9.5-*10.9*-12.5 (-13.0) X 3.0-*3.6*-4.0 (-4.5) µm; Q=(2.25-) 2.57-*3.03*-3.67 (n=50/3), smooth in alkali and Melzer's mounts, oblong-cylindric to subfusiform or "boletoid", apices often obtuse; ± thin-walled; brownish yellow or yellowish brown like *Inocybe* spores, unreactive in Melzer's; apiculus small and indistinct. (Fig. 1a). Basidia 26-35 (-40) X 6-8 µm, 4-sterigmate, slenderly clavate, clavate, or cylindrico-clavate; hyaline but at times filled with rich ochraceous pigment or pigment granules in ammonia mounts, vinaceous in KOH (Fig. 1b). Pleurocystidia absent. Cheilocystidia absent but edges of lamellae may bear scattered sterile elements, these short, clavate, and thin-walled, 15-20 X 6-8 µm, mixed with basidia (Fig. 1c). Caulocystidia absent, terminal cells at times clavate or undifferentiated; stipe hyphae with conspicuous interhyphal pigment deposits, occasionally with incrusted appearance. Lamellar trama parallel, "Apricot Buff" or reddish yellow (7.5YR 6/8) in mass, hyphae cylindric to inflated, up to 15 µm diam; hyphae with scattered pockets of intense refractive ochraceous pigments, these at times appearing incrusted, becoming hyaline in KOH after diffusion of vinaceous pigments in solution. Clamps present.

Gregarious to scattered or solitary in sandy soil in pine, pine-hardwood areas, or near *Arctostaphylos*, North America—Illinois, Florida, Michigan, Minnesota, New York, and west to Oregon and Washington; September to January.

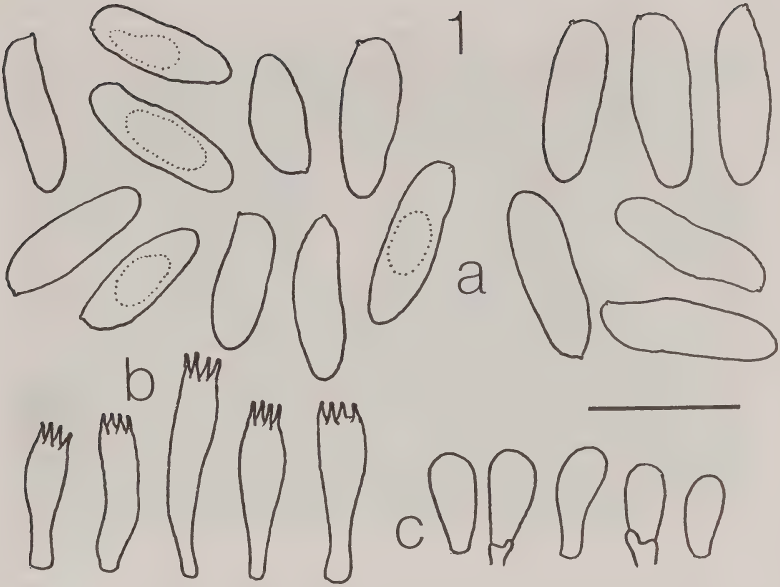

Fig. 1. Basidiospores (a), basidia (b), and sterile cells from the lamellar edge (c) of *Cortinarius aureifolius*. The 10 basidiospores at left are from the holotype of *I. angustispora*; the 6 at right are from the isotype of *I. taedophila*. The 4 left basidia are from *I. angustispora*; the far right basidium is from *I. taedophila*. The sterile basidiole-like elements from the lamellar edge are from *I. angustispora*. The scale bar is equal to 10 µm for spores and 25 µm for other cells.

Material examined: UNITED STATES: FLORIDA: northwest of Gainesville, under *Pinus taeda* (Loblolly Pine), 13 Jan. 1940, leg. W. A. Murrill, **F22484** (isotype of *I. taedophila*, WTU). NEW YORK: Karuer, in sandy soil under trees, 250 ft elev, 25 Sept. 1970, leg. S. Smith, C. Rogerson & W. Malarkey, **NYS 45814** (NYS); Oneida Co., Rome Sand Plains, in sand under mixed *Pinus* and *Quercus*, 15 Oct. 1996, leg. A. F. Bessette, **Bessette 10705** (holotype of *I. angustispora*, NYS). WASHINGTON: Pierce Co., Buck Creek, off HWY 410, near the Ranger Creek State Airport, on side of road in sandy soil under *Arctostaphylos*, *Pinus*, *Abies*, *Tsuga*, and *Pseudotsuga*, 27 Oct. 2000, leg. P. B. Matheny, **PBM 2018** (var. *hesperius*, WTU).

Commentary: The gross morphological description is modified from Bessette & Fatto (1998) and the description of *Inocybe angustispora*. The distribution data are drawn from Ammirati & Gilliam (1975) and supplemented with additional collections from New York and Florida. *Cortinarius aureifolius* has been described in *Inocybe* on two separate occasions (Murrill, 1944; Bessette & Fatto, 1998) and continues to be misinterpreted in *Inocybe* by regional floras in North America (Bessette, Bessette, & Neill, 2001). Taxonomic confusion with *Inocybe* is chiefly attributed to the densely fibrillose texture of the pileus, inocyboid-habit, and smooth brownish yellow basidiospores. However, the vinaceous red reaction of fruitbody tissues to KOK and presence of interhyphal pigment deposits in dried material that dissolve in KOH are traits that characterize members of subgenus *Dermocybe* of *Cortinarius* (Ammirati & Smith, 1969; Ammirati & Gilliam, 1975). The types of both *I. taedophila* and *I. angustispora* exhibit interhyphal pigment deposits (anthraquinone pigments), typical for subgenus *Dermocybe*, and feature the narrowly cylindric or "boletoid" smooth basidiospores. Both occur in sandy areas as

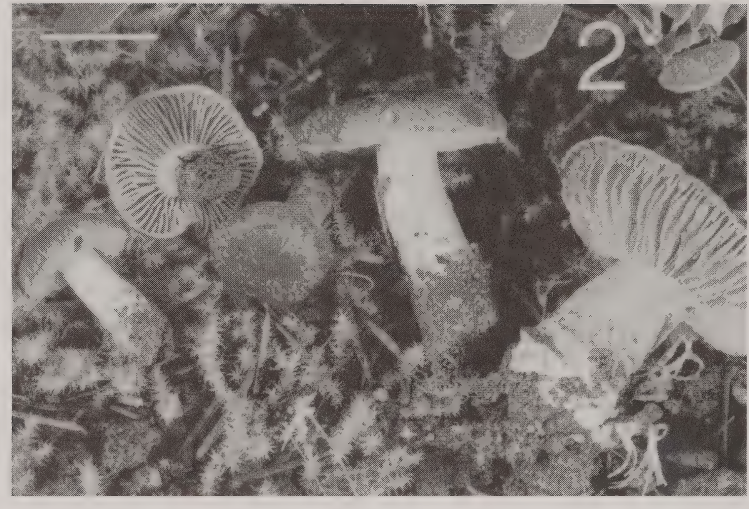

Fig. 2. Basidiomes of *Cortinarius aureifolius* var. *hesperius* from Pierce County, Washington. (PBM 2018). The scale bar is equal to 1 cm. A photo of *C. aureifolius* var. *aureifolius* can be seen in Bessette, Bessette, & Neill (2001) (as *I. angustispora*).

described for *C. aureifolius* and the western North American variety, *C. aureifolius* var. *hesperius* Ammirati (Ammirati & Gilliam, 1975), which differs by its light orange-ochraceous lamellae when young. The pigment composition of *C. aureifolius* is composed almost entirely of endocrin, which led Høiland (1984) to establish its own section, *Aureifoli*, in subgenus *Dermocybe*. DNA sequences from RPB1 and RPB2 of the holotype of *I. angustispora* show it is closely related to *C. croceus* (Schaeff.) Bigeard & Guillemin (see below).

Cortinarius psammophilus Ammirati & Smith is considered a synonym of *C. aureifolius* by Ammirati (1988). The olive to yellowish shades on the pileus of this variant were observed on *I. angustispora* based on the protologue.

PHYLOGENETIC RESULTS

The RPB1 data set includes 9 accessions and a total of 1341 characters, including positions from 4 spliceosomal introns. Of these, 298 characters are parsimony-informative and 121 autapomorphic. The RPB2 data set includes 11 accessions and a total of 752 characters, including positions from one spliceosomal intron. 262 parsimony-informative and 49 autapomorphic sites are included. Exon regions of both genes align easily with only a single autapomorphic amino acid insertion in the RPB2 sequence of *Crepidotus*. Ambiguously aligned sites of intron regions in both genes were excluded from analysis.

MP analysis of both data sets produced single optimal trees ($L_{RPB1} = 743$, $CI = 0.763$; $L_{RPB2} = 688$, $CI = 0.670$), which are shown unrooted in Fig. 3. Both genes support a close phylogenetic relationship between *Inocybe angustispora* and *Cortinarius croceus* (100% bootstrap support in both instances), consistent with the classification of this species in subgenus *Dermocybe* (Ammirati & Smith, 1969; Ammirati & Gilliam, 1975; Høiland, 1984; Liu, Rogers, & Ammirati 1997). Despite the smooth, pale basidiospores observed under the light microscope, *I. angustispora* is not related to other members of subgenus *Mallocybe* of *Inocybe* as proposed by Bessette & Fatto (1998). Indeed, both *I. angustispora* and *C. croceus* form strongly supported monophyletic groups (90-100%) with *C. fibrillosus* Cleland and an undescribed species of *Protoglossum* from Australia. Thus, morphological and phylogenetic evidence point to a close relationship between *C. aureifolius* and *C. croceus.*

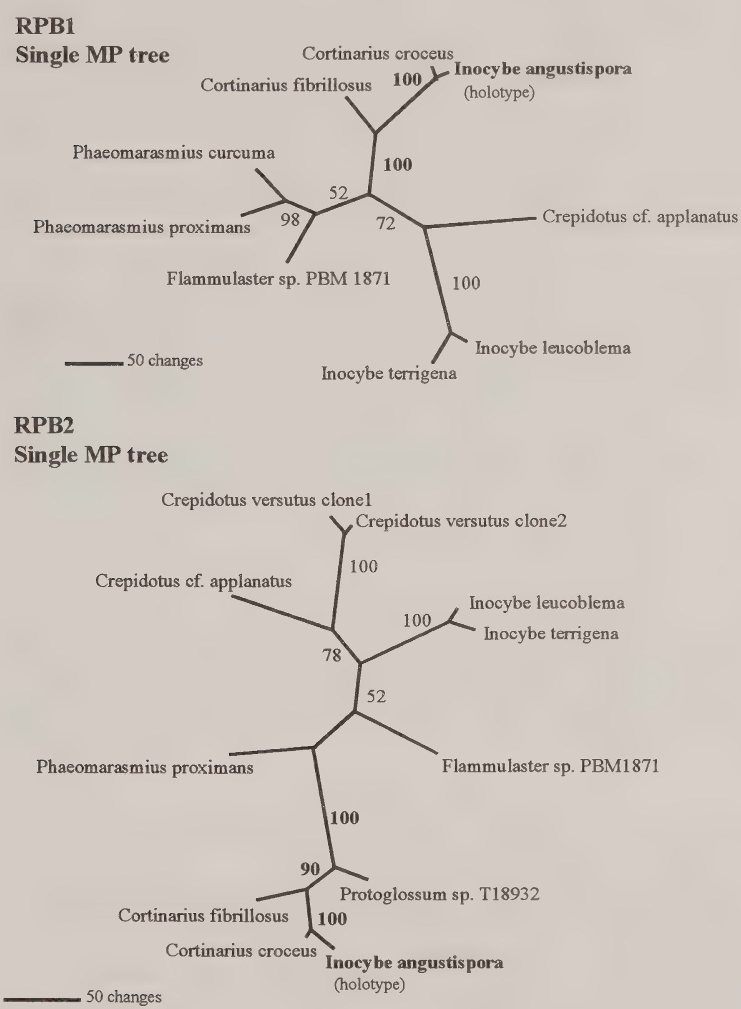
RPB1
Single MP tree
Cortinarius croceus
Inocybe angustispora
(holotype)
Cortinarius fibrillosus
100
100
Phaeomarasmius curcuma
52
Phaeomarasmius proximans
98
72
Crepidotus cf. applanatus
Flammulaster sp. PBM 1871
100
Inocybe leucoblema
Inocybe terrigena
50 changes
RPB2
Single MP tree
Crepidotus versutus clone1
Crepidotus versutus clone2
100
Crepidotus cf. applanatus
Inocybe leucoblema
100
Inocybe terrigena
78
52
Phaeomarasmius proximans
Flammulaster sp. PBM1871
100
90
Protoglossum sp. T18932
Cortinarius fibrillosus
100
Cortinarius croceus
Inocybe angustispora
(holotype)
50 changes

Fig. 3. RPB1 (top) and RPB2 (bottom) gene phylogenies of *I. angustispora*. Both trees represent the single MP tree based on a branch and bound search. Branch and bound bootstrap values higher than 50% are indicated next to branches. *Inocybe angustispora* and bootstrap values indicating its relationship to other cortinarioid taxa are indicated in bold type. Taxonomically, this species and *I. taedophila* are the same as *Cortinarius aureifolius.*

INTERHYPHAL PIGMENT DEPOSITS AND RPB1 AND RPB2 SEQUENCES SUPPORT INOCYBE ANGUSTISPORA IN CORTINARIUS

Inocybe angustispora Bessete & Fatto was evaluated taxonomically and phylogenetically as part of a broad systematic study of *Inocybe* (Fr.) Fr. (Matheny, 2003). An examination of the holotype of this species and the isotype of *I. taedopohila* Murrill confirmed the presence of interhyphal pigment deposits in the trama of the pileus, lamellae, and stipe, indicative of subgenus *Dermocybe* of *Cortinarius* (Ammirati & Smith, 1969; Ammirati & Gilliam, 1975; Høiland, 1984). The combination of the smooth, brownish yellow, "boletoid" basidiospores and occurrence in sandy soil under *Pinus* confirms its taxonomic identity with the same fungus described earlier by Peck (1885) as *C. aureifolius.*

The basidiospores of *C. aureifolius* are similar in appearance under the light microscope to those of *I. malenconi* Heim, *I. althoffiae* Horak, and *I. lacera* (Fr.: Fr) P. Kumm., and, of these, are as narrow as those for *I. althoffiae* (Matheny, 2003). However, scanning electron microscope studies of the basidiospores of *C. aureifolius* have revealed a weak roughened surface, the pattern of which is consistent with species of subgenus *Dermocybe* (Ammirati & Gilliam, 1975). *Cortinarius aureifolius* (as *I. angustispora*) is closely related to *C. croceus* (Fig. 3), which supports the systematic importance of interhyphal pigment deposits (anthraquinone pigments) in this group of *Cortinarius* species (Liu, Rogers, & Ammirati, 1997). Both *C. fibrillosus* and *Protoglossum* sp. T18932 are cortinarioid taxa that lack interhyphal pigment deposits. Incidentally, *C. fibrillosus* has also been confused with *Inocybe* in Australia, but this will be addressed elsewhere (Matheny & Bougher, unpublished data).

The reddish vinaceous reaction of flesh to weak alkali solutions like 3% KOH or 10% NH_4OH, in combination with the densely fibrillose pileus and occurrence in sandy soil under *Pinus* and/or *Arctostaphylos*, serve as field characters to distinguish *C. aureifolius* from species of *Inocybe*. Very few species of *Inocybe* exhibit a similar color reaction to weak alkali solutions (e. g., *I. tahquamenonensis* Stuntz and *I. magnifica* (Horak) Garrido), but their gibbous spores easily place them in *Inocybe* rather than *Cortinarius.*

ACKNOWLEDGMENTS

Dr. Benjamin Hall and Dr. Yajuan Liu were instrumental in supporting our sequencing efforts. We also would like to thank Dr. John Haines at NYS for providing the holotype of *Inocybe angustispora* and New York material of *I. taedophila.* Material was also shared by Drs. Neale Bougher, Michael Castellano, Jim Trappe, and Jukka Vauras. Dr. Scott Redhead kindly reviewed the manuscript.

LITERATURE CITED

Ammirati, J. F. (1988). *Dermocybe* (Cortinariaceae, Agaricales): North American names—new combinations, synonyms and notes. *Mycotaxon* 33: 437-446.

Ammirati, J. F. and Gilliam, M. S. (1975). *Cortinarius*, section *Dermocybe*: futher studies on *Cortinarius aureifolius* in: Studies on higher fungi: a collection of papers dedicated to Dr. Alexander H. Smith on the occasion of his seventieth birthday (eds) H. E. Bigelow and H. D. Thiers. *Beihefte zur Nova Hedwigia* 51: 39-52.

Ammirati, J. F. and Smith, A. H. (1969). Studies in the genus *Cortinarius*, I: section *Dermocybe, Cortinarius aureifolius* complex. *Michigan Botanist* 8: 175-180.

Bessette, A. E. and Fatto, R. M. (1998). Two narrow-spored Inocybes. *Mycotaxon* 66: 121-126.

Bessette, A. R., Bessette, A. E., and Neill, W. J. (2001). *Mushrooms of Cape Cod and the National Seashore.* Syracuse University Press, Syracuse, New York, USA.

Felsenstein, J. (1985). Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783-791.

Høiland, K. (1984). *Cortinarius* subgenus *Dermocybe. Opera Botanica* 71: 5-113.

Holmgren, P. K., Holmgren, N. H., and Barnett, L. C. (1990). *Index herbariorum*. 8th edition. New York Botanical Garden, Bronx, New York, USA.

Liu, Y. J., Rogers, S. O., and Ammirati, J. F. (1997). Phylogenetic relationships in *Dermocybe* and related *Cortinarius* taxa based on nuclear ribosomal DNA internal transcribed spacers. *Canadian Journal of Botany* 75: 519-532.

Liu, Y. J., Whelen, S., and Hall, B. D. (1999). Phylogenetic relationships among Ascomycetes: evidence from an RNA polymerase II subunit. *Molecular Biology and Evolution* 16: 1799-1808.

Matheny, P. B., Liu, Y. J., Ammirati, J. F., and Hall, B. D. (2002). Using RPB1 sequences to improve phylogenetic inference among mushrooms (*Inocybe*, Agaricales). *American Journal of Botany* 89: 688-698.

Matheny, P. B. (2003). *Molecular systematics and taxonomic contributions towards the Inocybaceae*. PhD Disseration, University of Washington, Seattle, Washington, USA.

Munsell soil color charts (1954). Munsell Color Company, Inc., Baltimore 18, Maryland, USA.

Murrill, W. A. (1944). New Florida fungi. *Proceedings of the Florida Academy of Sciences* 7: 107-128.

Peck, C. H. (1885). Report of the state botanist. *Annual Report on the New York State Museum of Natural History* 38: 77-138.

Ridgway, R. (1912). *Color standards and color nomenclature*. Published by the author, Washington, D. C., USA.

Swofford, D. L. (2003). *PAUP*. Phylogenetic analysis using parsimony (*and other methods)*, Version 4. Sinauer, Sunderland, Massachusetts.

Thompson, J. D., Gibson, T. J., Plewniak, F., Jeanmougin, F. and Higgins, D. G. (1997). The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25: 4876-4882.

APPENDIX

The following collections were used in this study. Herbarium abbreviations follow that of Holmgren, Holmgren, and Barnett (1990): *Inocybe terrigena* (JV 16431-Finland, TURA, WTU); *I. leucoblema* (JV 16437-Finland, TURA, WTU); *Crepidotus* cf. *applantus* (PBM 717-Washington, WTU); *C. versutus* (PBM 856-Washington, WTU); *Flammulaster* sp. (PBM 1871-Washington, WTU); *Phaeomarasmius curcuma* (JFA 11323-Wyoming, WTU); *P. proximans* ined. (PBM 1936-Vermont, WTU); *Cortinarius fibrillosus* (E6584-Western Australia, CSIRO-PERTH); *C. croceus* (JFA 12611-Wyoming, WTU); *Protoglossum* sp. (T18932, New South Wales, Australia, OSC).

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MYXOMYCETES FROM CHIHUAHUA, MEXICO

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Abstract: A first check list of Myxomycetes from the state of Chihuahua is presented, including 182 collections representing 61 different taxa. Four of them, *Cribraria confusa, Cribraria minutissima*, *Echinostelium corynophorum* and *Trichia persimilis* are first records for Mexico and are decribed in detail. SEM and OM micrographs of spore ornamentation and sporocarps are given for the species new to Mexico and for difficult taxa.

Key words: chorology, Myxomycota, SEM, taxonomy

INTRODUCTION

Chihuahua is the largest state in Mexico with an area of 245.612 km^2 and contains a large diversity of ecosystems, e.g. conifer and oak forest, tropical caducifolious forest, xerophilous thicket and pastureland (RZEDOWSKY, 1994). From the point of view of the Myxomycetes it has little studied. Only three taxa have been cited, *Stemonitis fusca* by BRAUN & KELLER (1976), *Lycogala epidendrum* by QUIÑONES & *al.* (2000) and recently *Calonema foliicola*, a species described as new, by ESTRADA-TORRES & *al.* (2003).

The aim of this study is to contribute to the creation a first catalogue of Myxomycetes of Chihuahua, in order to know their distribution and ecology in this state in particular and in Mexico in general.

MATERIALS AND METHODS

All the material has been collected in the field or obtained in moist chamber cultures. The major part of the material was presented at the Fourth Latin American Congress of Mycology by LIZÁRRAGA (2002). The intention of the current work is to complete the information about ecology and chorology.

The specimens are deposited in the Herbarium UACJ of the "Departamento Ciencias Básicas Universidad Autónoma de Ciudad Juárez", Mexico. A duplicate of rare species or species new for Mexico are deposited in the herbarium AH of the "Departamento de Biología Vegetal (Botánica), Universidad de Alcalá, Alcalá de Henares, Madrid", Spain.

Detailed descriptions are given only for species that are first records for Mexico. The collected material was mounted in Hoyer's medium and studied with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) images were made with a Zeiss DSM-950. The optical microscope (OM) was used to make spore measurements under oil immersion and include surface structures such as spines or warts. Observations of the spore ornamentation by SEM have been made after applying the critical point drying technique as indicated in MORENO & *al.* (2002).

LIST OF SPECIES

***Arcyria cinerea* (Bull.) Pers.**

Material examined. Cusarare Guachochi, bark of *Quercus* sp., *leg.* M. Lizárraga & J. Vargas, 7-V-2000, obtained from moist chamber culture on 25-V-2000, UACJ 131. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg.* M. Lizárraga, 10-VIII-2000, UACJ 290.

Observations: This is a very abundant species in Mexico (ILLANA & *al.*, 2000).

***Arcyria denudata* (L.) Wettst.**

Material examined. Basaseachic, Ocampo, on decomposing wood, *leg*, M. Lizárraga, 11-VIII-2001, UACJ 345. *Idem*, on bark of *Pinus* sp., 10-VIII-2002, UACJ 306. *Idem*, on soil, 2-VIII-2002, UACJ 316.

Observations: *Arcyria denudata* is a very common species in Mexico (ILLANA & *al.*, 2000).

***Arcyria pomiformis* (Leers) Rostaf.**

Material examined. Cusarare, Guachochi, on twigs of *Quercus* sp., *leg.* M. Lizárraga, 11-VIII-2001, UACJ 346.

Observations: *Arcyria pomiformis* is known in Mexico only from the states of Baja California, Baja California Sur and Veracruz (ILLANA & *al.* 2000).

***Badhamia melanospora* Speg.**
= *B. gracilis* (T. Macbr.) T. Macbr.

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, Juárez, dry leaves of *Yuca elata*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber culture on 4-II-2000, UACJ 142 and 146. *Idem*, 7-II-2000, UACJ 135. *Idem*, 9-II-2000, UACJ 132, 136 and 137. *Idem*, 17-II-20 UACJ 139. *Idem*, 22-II-2000, UACJ 138 and 140. Sierra Presidio, Samalayuca Juárez, on cladodes of *Opuntia* sp., *leg.* M. Lizárraga, obtained from moist chamber culture on 8-II-2000, UACJ 133, 143 on 147. *Idem*, 12-II-2000, AUCJ 145. *Idem*, 14-III-2000, UACJ 134 and 144. Presa Casa de Adobe, Janos, on cladodes of *Opuntia* sp., *leg.* M. Lizárraga, UACJ 141.

Observations: The type material of *Badhamia melanospora* was studied recently by CASTILLO & *al.* (1996). In this work we follow the taxonomic treatment proposed by LADO (2001).

Badhamia melanospora has been cited from the states of Baja California, Baja California Sur, State of Mexico and Tlaxcala (ILLANA & *al.*, 2000). This species is very abundant in the state of Chihuahua on Cactaceae and can frequently be found in moist chamber cultures.

Badhamia utricularis **(Bull.) Berk.**

Material examined. Basaseachic, Ocampo, on bark of *Pinus* sp., *leg.* M. Lizárraga, 10-VIII-2002, UACJ 314 and 315.

Observations: *Badhamia utricularis* has been cited only from the State of Mexico by BRAUN & KELLER (1976). This is the first record for Chihuahua.

Ceratiomyxa fruticulosa **(O. F. Mull) T. Macbr.**

Material examined. Basaseachic, Ocampo, on bark of *Pinus* sp., *leg.* M. Lizárraga, 10-VIII-2002, UACJ 310.

Observations: There are many records of *Ceratiomyxa fruticulosa* from Mexico (ILLANA & *al.*, 2000), but this is the first record for Chihuahua.

Comatricha laxa **Rostaf.**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, Juárez, on dry stems of *Larrea tridentata*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber culture on 27-I-2000, UACJ 148. *Idem*, 5-II-2000, UACJ 149. *Idem*, 28-II-2000, UACJ 275. Santa Rita, Coyame, on stems of *Larrea tridentata*, *leg.* J. Vargas, 6-VI-2000, obtained from moist chamber culture on 10-VI-2000, UACJ 150 and 151.

Observations: *Comatricha laxa* is frequently found in moist chamber cultures of material from desert zones. It is characterized by its small sporocarps, globose to subcylindrical sporothecae and can be distinguished from small forms of *C. nigra* by its rigid and laxer capillitium and its spores 9-10 µm in diam. *C. nigra* has a sinuous capillitium and smaller spores 7-8 µm in diam.

This species has been cited from Quintana Roo and Tlaxcala (ILLANA & al., 2000), Baja California (MORENO & al., 2001) and, recently, from Tlaxcala (RODRÍGUEZ-PALMA & *al.*, 2002).

Comatricha nigra **(Pers. ex J. F. Gmel.) J. Schröt.**

Material examined. Basaseachic, Ocampo, on wood of *Pinus* sp., *leg.* M. Lizárraga & J. Vargas, 6-V-2000, obtained from moist chamber culture on 13-V-2000, UACJ 273 and 276.

Observations: This ubiquitous species has been cited from Baja California, State of Mexico, Morelos, Nuevo León, Tlaxcala and Veracruz (ILLANA & *al.*, 2000). This is a first record for Chihuahua.

Comatricha pulchella **(C. Bab.) Rostaf. (Figs. 1-2)**

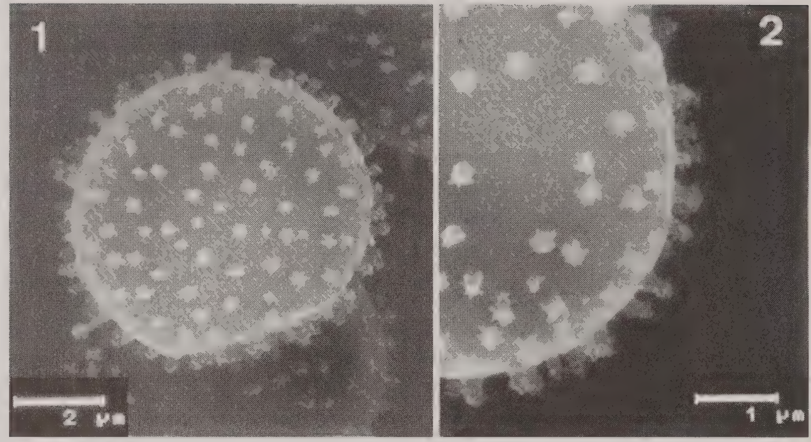
Material examined. Cusarare, Bachochi, on leaves of *Quercus* sp., leg. M. Lizárraga, 11-VIII-2001, UACJ 152.

Observations: The only records of *Comatricha pulchella* are from the states Jalisco, Oaxaca and Veracruz (ILLANA & *al.*, 2000). This is a folicolous species characterized by its small spores 6-7 µm in diam., with an ornamentation formed by baculae with a star-shaped apex under SEM and a typical sinuous capillitium.

Craterium leucophaeum **(Pers. ex J. F Gmel.) Ditmar**

Material examined. San Juanito Bocyna, on leaves of *Quercus crassifolia*, *leg.* M. Lizárraga, H. Pelayo & A. Aguirre, 13-X-2001, UACJ 350 and 351.

Observations: This is an ubiquitous species often cited from Mexico (ILLANA & *al.* 2000). This is a first record for Chihuahua.



Figs. 1-2. ***Comatricha pulchella*** **(UACJ 152):** 1. Spore al SEM. 2. Detail of spore ornamentation.

Craterium minutum **(Leers) Fr.**

Material examined. San Juanito Bocyna, on dry leaves of *Quercus crassifolia*, *leg*. M. Lizárraga, H. Pelayo & A. Aguirre, 13-X-2001, UACJ 347, 348 and 349.

Observations: *Craterium minutum* is an ubiquitous species, cited only from Baja California and Tlaxcala (ILLANA & *al.* 2000). This is a first record for Chihuahua.

Cribraria aurantiaca **Schrad.**

Material examined. Cusarare, Bachochi, on Word of *Pinus* sp., *leg.* M. Lizárraga, 11-VIII-2001, UACJ 163, 164 in AH 31703, 165 and 167. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg.* M. Lizárraga, 10-VIII-2000, UACJ 288.

Observations: There are records of *Cribraria aurantiaca* from Morelos and Quintana Roo (ILLANA & *al.* 2000) only. This is a first record for Chihuahua.

Cribraria cancellata **(Batsch) Nann.-Bremek.**

Material examined. San Juanito Bocoyna, on bark of *Pinus arizonica*, *leg.* M. Lizárraga & J. Vargas, 6-VIII-2000, UACJ 153, 154 and 155.

Observations: *Cribraria cancellata* is an ubiquitous species, that has frequently been cited from Mexico (ILLANA & *al.* 2000). This is a first record for Chihuahua.

Cribraria confusa **Nann.-Bremek. & Y. Yamam. (Figs. 3-5)**

Material examined. Basaseachic, Ocampo, bark of *Pinus* sp., *leg.* M. Lizárraga & J. Vargas, 6-V-2000, obtained from moist chaber cultura on 1-VI-2000, UACJ 160 (duplo in AH 31701). *Idem*, 13-V-2000, UACJ 156, 158, 159, 269 and 274.

Sporocarps 0.2-0.9 mm in height, grouped to scattered, stalked, yellow. Sporotheca 0.08-0.2 mm in diam., globose to subglobose. Peridium evanescent except in the base that is persistent in a more or less radiate form, from which the threads originate forming a net of polygonal meshes up to 35 µm in diam., threads narrow, about 1 µm in diam. Small mounds of calcic granules are present at the union of the threads. Stalk 0.3-0.7 mm in height and 30-50 µm broad, straw-yellow, with granular material from the half of its height to the base. Hypothallus inconspicuous. Spores 5-6 µm in diám., globose to subglobose, warted, yellowish in mass, light yellow by OM. With SEM spore ornamentation is formed by small scattered baculae of irregualr distribution.

Cribraria confusa is characterized by its small sporocarps, its long stalk and small globose sporothecae, the peridial net with more or less isodiametric threads and sparse calcic granules.

Cribraria confusa has been described by NANNENGA-BREMEKAMP & YAMAMOTO (1983), separating it clearly from *C. minutissima* Schwein. The two species were compared using SEM by KELLER & *al.* (1988).

Cribraria costata Dhillon & Nann.-Bremek. differs by the base of the peridial net formed by very elongated threads and the presence of abundant calcic granules in the nodes of the peridial net. This species has been described by DHILLON & NANNENGA-BREMEKAMP (1978). This species is a first record for Mexico.

***Cribraria microcarpa* (Schrad.) Pers.**

Material examined. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg.* M. Lizárraga, 10-VIII-2000, UACJ 157, 293 and 309.

Observations: This species has been cited only from the state of Veracruz (ILLANA & *al.*, 2000) and this is the first record for Chihuahua.

***Cribraria minutissima* Schwein. (Figs. 6-8)**
= *C. microscopica* Berk. & M. A. Curtis

Material examined. Basaseachic, Ocampo Chihuahua., on decomposing Word of *Pinus* sp., *leg.* M. Lizárraga & J. Vargas, 6-V-2000, put in mois chamber on 9-V-2000, obtained from moist chamber culture on 13-V-2000, UACJ 161, 166 in AH 31702, 270, 271 and 272.

Sporocarps grouped to scattered, stalked, dark orangeish, 0.3-0.8 mm in total height. Sporotheca 0.12-0.14 mm in diam., subglobose to pyriform, somewhat constricted in the centre. Peridium single, covering about 2/3 parts of the sporotheca in the form of peridial caliculus in its base, orangeish, with calcic granules over its surface, the net formed by threads 2-4 µm in diam., meshes polygonal to isodiametric, yellowish brown. Stalk 0.3-0.4 mm in height, broader towards the base (30-60 µm) and narrow towards the apex (13-15 µm), straw-yellow, longitudinally furrowed, with brown granular material from half the height of the stalk to the base. Hypothallus inconspicuous. Columella absent. Capillitium absent. Spores 7-8 µm in diam., subglobose, minutely punctate, light yellow to colourless by OM and orangeish yellow in the mass. Protoplasmodium carmine red.

Observations: This is a very abundant species in moist chambers on decomposing wood of *Pinus arizonica*. Sometimes it fructifies together with *Comatricha nigra* and *Cribraria confusa*.

MARTIN & ALEXOPOULOS (1969) mention a blackish blue plasmodium, whereas the colour of the plasmodium observed by us is carmine red. The differences between *Cribraria confusa* and *C. costata* are indicated above. This is the first record for Mexico.

Cribraria violacea **Rex**

Material examined. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg*. M. Lizárraga, 10-VIII-2002, UACJ 322.

Observations: This is a very abundant species in Mexico (ILLANA & *al*., 2000; MORENO & *al*., 2001).

Dianema harveyi **Rex**

Material examined. Sierra de Presidio, Samalayuca Juárez, on stems of *Larrea tridentata*, *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber culture on 15-II-2000, UACJ 168.

Observations: Although our material consists only of a single well matured specimen, the capillitium formed by parallel tubules bearing small papillae on its surface, originating from the base and extending towards the upper part of the peridium, and spiny spores 9-11 µm diam., olivaceous by OM can be observed.

Dianema harveyi has been previously cited only from Baja California by ILLANA & *al*. (2000).

Diderma hemisphaericum **(Bull.) Hornem.**

Material examined. Presa Casa de Adobe, Janos, on leaves of *Quercus* sp., *leg*. M. Lizárraga, 2-IX-2001, UACJ 169.

Observations: This species has been cited from Baja California, Chiapas, Nuevo León, Tabasco, Tlaxcala and Veracruz (ILLANA & *al*., 2000).

Didymium anellus **Morgan**

Material examined. Colonia Partido Las Fuentes, Ciudad Juárez, on dry leaves of *Populus tremuloides*, *leg*. M. Lizárraga & R. Rivas, 16-I-2000, obtained from moist chamber culture on 27-I-2000, UACJ 176. *Idem*, 31-I-2000, UACJ 171 and 172. *Idem*, 5-II-2000, UACJ 170 and 174. *Idem*, 8-II-2000, UACJ 175. *Idem*, 9-II-2000, UACJ 173.

Observations: This species has also been cited from Baja California, Guerrero and Tlaxcala (ILLANA & *al*., 2000).

Didymium dubium **Rostaf.**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, Juárez, on stems of *Larrea tridentata*, leg. M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber culture on 27-I-2000, UACJ 179, 192, 195 and 196. *Idem*, 28-I-2000, UACJ 193. *Idem*, 5-II-2000, UACJ 182 and 180. *Idem*, 22-II-2000, UACJ 177. *Idem*, 29-II-2000, UACJ 184. Sierra de Presidio, Samalayuca, Juárez, on leaves of *Yuca* sp., *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber culture on 12-II-2000, UACJ 186. *Idem*, on cladodes of *Opuntia* sp., 21-II-2000, UACJ 185. *Idem*, 29-II-2000, UACJ 187. *Idem*, on stems of *Larrea tridentata*, 21-II-2000, UACJ 188. *Idem*, 23-II-2000, UACJ 191 and 181. *Idem*, on horse dung, 3-

Figs. 3-5. *Cribraria confusa* (UACJ 160): 3. Sporocarp (scale bar 0.1 mm). 4. Detail of the peridial net (scale bar 0.01 mm). 5. Spore. **Figs. 6-8. *Cribraria minutissima* (UACJ 168):** 6. Sporocarp (scale bar 0.1 mm). 7. Detail of the caliculus and the peridial net (scale bar 0.01 mm). 8. Spore.

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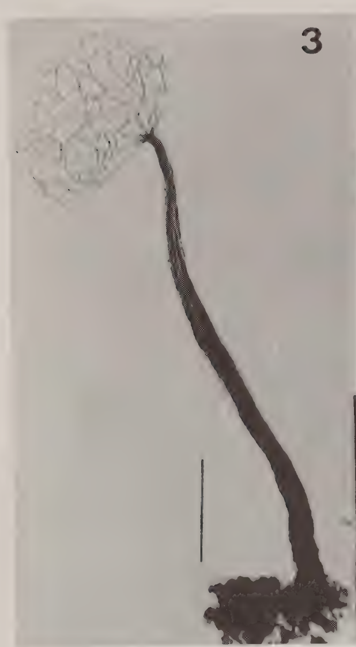

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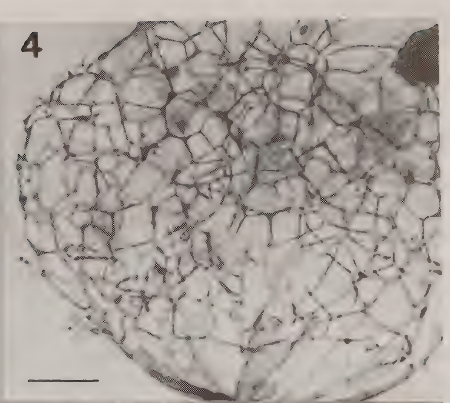

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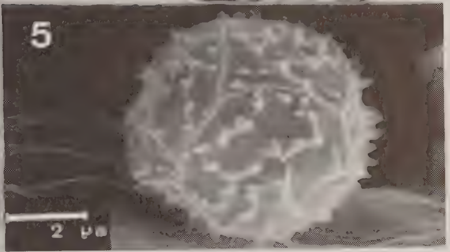

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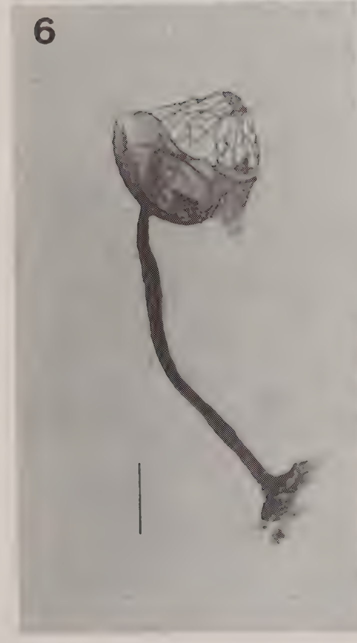

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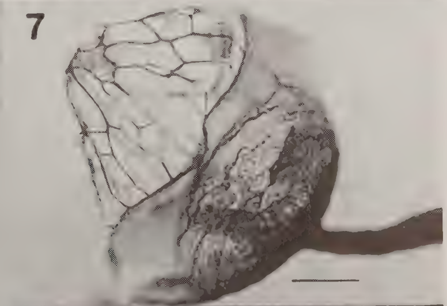

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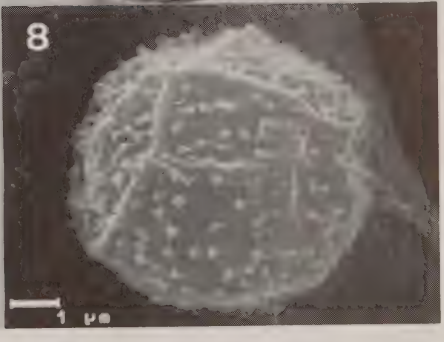


III-2000, UACJ 189 and 194. *idem*, 3-IV-2000, UACJ 190 and 162. *Idem*, 17-III-2000, UACJ 183. *Idem*, 25-III-2000, UACJ 178.

Observations: *Didymium dubium* is a common species in Chihuahua, from Baja California only one record is known (MORENO & *al.*, 2001).

***Didymium nigripes* (Link) Fr.**

Material examined. San Juanito Bocoyna, on leaves of *Quercus crassifolia*, leg. M. Lizárraga & J. Vargas, 5-VIII-2000, UACJ 198. Presa Casa de Adobe, Janos, on stems and leaves of *Quercus* sp., leg. M. Lizárraga, 2-IX-2001, UACJ 197.

Observations: This species has been cited from Baja California and Baja California Sur by MORENO & *al.* (2001) and from Chiapas by Veracruz (ILLANA & *al.*, 2000).

***Didymium squamulosum* (Alb. & Schwein.) Fr.**

Material examined. Colonia Partido las Fuentes, Ciudad. Juárez, Juárez, on leaves of *Populus tremuloides*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber cultura on 2-II-2000, UACJ 200. San Juanito, Bocoyna, on dry leaves of *Quercus crassifolia*, *leg.* M. Lizárraga & J. Vargas, 6-VIII-2000, UACJ 201. *Idem*, on decomposing leaves, UACJ 199.

Observations: This species has been cited from Baja California, Baja California Sur, Chiapas, State of Mexico, Jalisco, Morelos, Nuevo León, Queretaro, Puebla, Sinaloa, Tlaxcala and Veracruz (ILLANA & *al.*, 2000).

***Echinostelium arboreum* H. W. Keller & T. E. Brooks**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, on stems of *Larrea tridentata,* leg. M. Lizárraga & R. Rivas, 16-I-2000, obtained from moist chamber culture on 27-I-2000, UACJ 204. *Idem*, 28-I-20 UACJ 205.

Observations: *Echinostelium arboreum* has been cited only from Yucatan (ILLANA & *al.*, 2000) and Baja California (MORENO & *al.*, 2001)

***Echinostelium colliculosum* K. D. Whitney & H. W. Keller (Figs. 9-10)**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, on stems of *Larrea tridentata*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber culture on 27-I-2000, UACJ 202, 203, 208, 209, 210 and 211. *Idem*, 5-II-2000, UACJ 21. Sierra Presidio, Samalayuca Juárez, on stems of *Larrea tridentata*, *leg.* M. Lizárraga, 8-II-2000, obtained from moist chamber culture on 18-II-2000, UACJ 212. *Idem*, on leaves of *Yucca* sp., 12-II-2000, UACJ 221.

Observations: The only previous records of *Echinostelium colliculosum* are from Baja California Sur (MORENO & *al.*, 2001).

***Echinostelium corynophorum* K.D. Whitney (Figs. 11-14)**

Material examined. Sierra de Presidio, Samalayuca, on *Larrea tridentata leg*, M. Lizárraga, 8-II-2000, put in moist chamber on 10-II-2000, obtained from moist chamber cultura on 12-II-2000 together with *Echinostelium colliculosum*, UACJ 206.

Description: Sporocarps stipitate, grouped to scattered, 100-140 µm in total height: Sporotheca not observed. Peridium not observed except in the base where it persists in the form of a small collar. Columella 3-5 µm in diam., pedunculate-lenticular to pedunculate-globose, straw-yellow by OM. Stalk 70-100 µm in height, translucent by OM, broader in the base and filled with granular material in the lower 2/3. Hypothallus inconspicuous. Spores 10-12 µm, subglobose to globose, hyaline, with thin articular areas, with edges that taper to the spore surface. Capillitium absent.

Observations: *Echinostelium corynophorum* is characterized by its sporocarps with a lenticular to globose columella and spores with thin articular areas, with edges that taper to the spore surface. *Echinostelium brooksii* K.D. Whitney is a very closely-related species difficult to distinguish, differing by its spores lacking articular areas (WHITNEY, 1980). This species is a first record for Mexico.

***Echinostelium minutum* de Bary**

Material examined. Cusarare Guachochi, on bark of *Pinus* sp., *leg*. M. Lizárraga & J. Vargas, 7-V-2000, obtained from moist chamber cultura on 15-V-2000, UACJ 216. Basaseachic Ocampo, bark of *Pinus* sp., *leg*. M. Lizárraga & J. Vargas, 6-V-2000, obtained from moist chamber cultura on 18-V-2000, UACJ 219. *Idem,* 1-VI-2000, UACJ 217, 213 and 214. *Idem*, 5-VI-20 UACJ 215.

Observations: *Echinostelium minutum* has been cited from Guerrero, Morelos, Nuevo León, Puebla and Yucatan (ILLANA & *al.*, 2000), later from Baja California (MORENO & *al.*, 2001) and Tlaxcala (RODRIGUEZ-PALMA & *al.*, 2002).

***Fuligo cinerea* (Schwein.) Morgan**

Material examined. Sierra de Presidio, Samalayuca Juárez, on horse dung, *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber culture on 3-IV-2000, UACJ 220 and 224. Santa Rita, Coyame, on cow dung, *leg*. J. Vargas, 6-VI-2000, obtained from moist chamber culture on 30-VI-2000, UACJ 222. *Idem*, on rabbit dung, UACJ 223.

Observations: This species has been cited from Baja California, Nuevo León and Sonora (ILLANA & *al.*, 2000).

***Hemitrichia calyculata* Speg.**

Material examined. Basaseachic, Ocampo, on decomposing wood of *Quercus* sp., *leg*. M. Lizárraga, 10-VIII-2002, UACJ 317, 320 and 325.

Observations: *Hemitrichia calyculata* is a very common species frequently cited from Mexico (ILLANA & *al.*, 2000).

***Hemitrichia minor* G. Lister**

Material examined. Presa Casa de Adobe, Janos Chihuahua, on cladodes of *Opuntia* sp., *leg*. M. Lizárraga, 2-IX-2001, UACJ 225.

Observations: This species has been cited only from Baja California by LIZÁRRAGA & *al*. (1999).

***Hemitrichia serpula* (Scop.) Rostaf.**

Material examined. Basaseachic, on stems of *Quercus* sp., *leg*. M. Lizárraga & J. Vargas, 4-V-2000, UACJ 226 and 296. Basaseachic, Ocampo, on twigs of *Quercus* sp., *leg*. M. Lizárraga, 4-X-2002, UACJ 296, slide in AH 19899.

Observations: This species has been cited from Campeche, Chiapas, State of Mexico, Jalisco, Nuevo León, Oaxaca, Quintana Roo, Veracruz and Yucatán (ILLANA & *al.*, 2000).

***Lamproderma scintillans* (Berk. & Broome) Morgan**

Material examined. Janos, Presa casa de Adobe, *leg*. M. Lizárraga 13-IX-2001, on leaves of *Quercus* sp. UACJ 228.

Observations: There are records from Chiapas, Nuevo León and Tlaxcala (ILLANA & *al.*, 2000), and from Baja California (MORENO & *al.*, 2001).

***Leocarpus fragilis* (Dicks.) Rostaf.**

Material examined. Basaseachic, Ocampo, grouped on needles of *Pinus* sp., on leaves of *Quercus* sp. y *Arbutus* sp., *leg*. M. Lizárraga & J. Vargas, 6-V-2000, UACJ 230.

Observations: *Leocarpus fragilis* has been cited from the State of Mexico, Hidalgo, Jalisco, Nuevo León, Querétaro, Tlaxcala and Veracruz (ILLANA & *al.*, 2000).

***Licea biforis* Morgan**

Material examined. Dunas de Samalayuca, Juárez, tallos de *Polimenta* sp., *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber cultura on 8-IV-2000, UACJ 231. Sierra de Presidio, Samalayuca Juárez, on leaves of *Yuca* sp., *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber cultura on 14-IV-2000, UACJ 229.

Observations: This species has been cited only from the states of Baja California and Sinaloa by LIZÁRRAGA & *al.* (1998; 1999).

***Licea kleistobolus* G. W. Martín**

Material examined. Samalayuca Juárez, on stems of *Polimenta* sp., *leg*. M. Lizárraga, 8-II-2000, obtained from moist chamber cultura on 29-I-20, UACJ 236. *Idem*, tallos de *Prosopis glandulosa*, 28-II-2000, UACJ 233, 234 and 235. Basaseachic Ocampo, on bark of *Pinus* sp., *leg*. M. Lizárraga & J. Vargas, obtained from moist chamber cultura on 1-VI-2000, UACJ 232. *Idem*, 5-VI-20, UACJ 218.

Observations: *Licea kleistoboulous* has been cited only from the Federal District by BRAUN & KELLER (1986) and from Baja California by MORENO & *al.*, (2001).

***Licea minima* Fr.**

Material examined. San Juanito Bocoyna, on wood of *Pinus arizonica*, 6-VIII-2000, *leg*. M. Lizárraga & J. Vargas, UACJ 237.

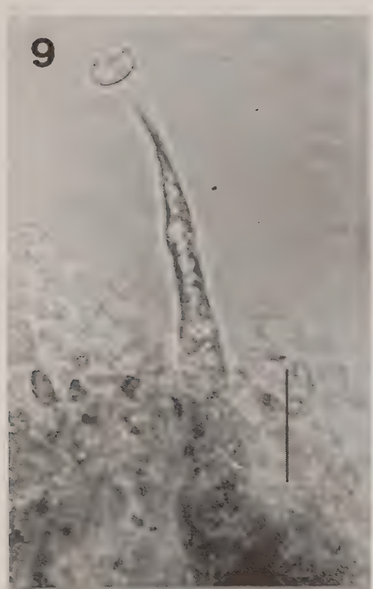
Observations: The only known records of *Licea minima* are from Jalisco and Tlaxcala (ILLANA & *al.*, 2000).

***Licea variabilis* Schrad.**

Material examined. San Juanito, Bocoyna, on decomposing Word of *Pinus arizonica*, *leg*. M. Lizárraga, 11-VIII-2001, UACJ 238.

Observations: The species was cited from Baja California by LIZÁRRAGA & *al.* (1999).

Figs. 9-10. *Echinostelium colliculosum* (UACJ 206): 9. Sporocarp (scale bar 10µm). 10. Spores with articular areas (scale bar 10µm). **Figs. 11-14. *Echinostelium corynophorum* (UACJ 206):** 11-12. Sporocarps (scale bar 10µm). 13-14. Spores with articular areas (scale bar 10µm). **Figs. 15-16. *Macbrideola decapillata* (UACJ 344):** 15. Sporocarp with stalk and elongated columella (scale bar 25 µm). 16 Spore (scale bar 10µm). **Figs. 17-18 *Trichia persimilis* (AH 31704).** 17. Capillitium. 18. Detail of spore ornamentation.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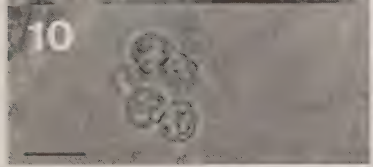
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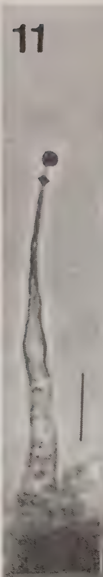
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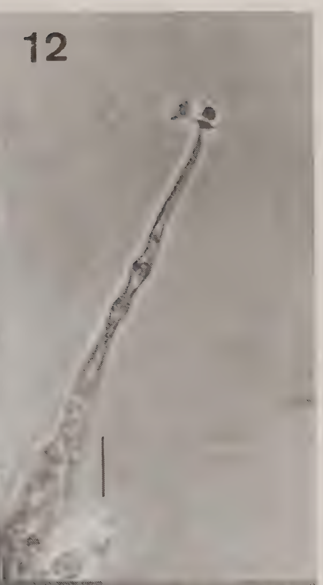
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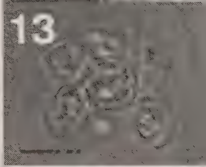
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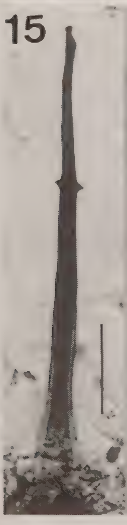
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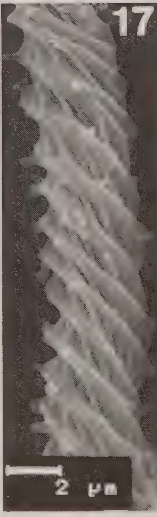
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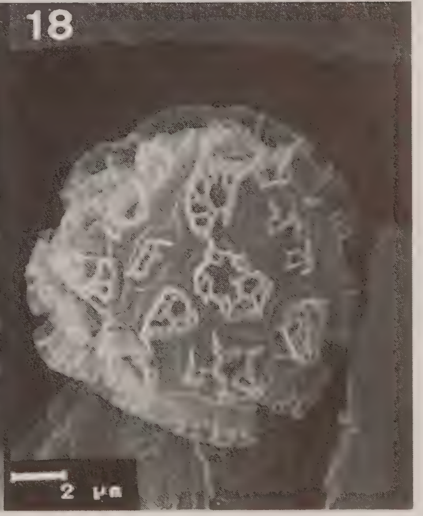
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2 μm

***Lycogala epidendrum* (L.) Fr.**

Material examined. San Juanito Bocoyna, on decomposing wood of *Pinus arizonica*, *leg.* M. Lizárraga, 11-VIII-2001, UACJ 239.

Observations: This species is very common in Mexico (ILLANA & *al.*, 2000).

***Macbrideola decapillata* H. C. Gilbert (Figs. 15-16)**

Material examined. Presa Casa de Adobe, Janos, on bark of *Quercus* sp., 13-IX-2001, *leg.* M. Lizárraga, UACJ 239.

Observations: *Macbrideola decapillata* is known only from Puebla (KELLER & BRAUN, 1977).

***Metatrichia vesparia* (Batsch) Nann.-Bremek.**

Material examined. Basaseachic Ocampo, on decomposing wood, 27-X-2002, *leg.* M. Lizárraga, UACJ 328.

Observations: There are records of *Metatrichia vesparia* from Jalisco, Michoacán, Morelos, Nuevo León, Querétaro, Tlaxcala, Veracruz and Yucatán (ILLANA & *al.*, 2000).

***Perichaena chrysosperma* (Curr.) Lister**

Material examined. Presa Casa de Adobe, Janos, on cladodes of *Opuntia* sp., *leg.* M. Lizárraga, 2-IX-2001, UACJ 247.

Observations: This species has been cited from Baja California, Baja California Sur, Chiapas, Guerrero, Jalisco, Puebla, Quintana Roo, Sinaloa and Veracruz (ILLANA & *al.*, 2000).

***Perichaena corticalis* (Batsch) Rostaf.**

Material examined. Cusarare Guachochi, on bark of *Quercus* sp., *leg.* M. Lizárraga & J. Vargas, 6-V-2000, obtained from moist chamber cultura on 1-VI-2000, UACJ 241. San Juanito Bocoyna, on stems of *Quercus crassifolia*, 6-VIII-2000, *leg.* M. Lizárraga & J. Vargas, UACJ 240.

Observations: *Perichaena corticalis* was previously known only from the state of Tlaxcala (RODRÍGUEZ-PALMA & *al.*, 2002).

***Perichaena depressa* Lib.**

Material examined. Sierra de Presidio, Samalayuca Juárez, on dry cladodes from *Opuntia* sp., *leg.* M. Lizárraga, 8-II-2000, obtained from moist chamber cultura on 14-IV-2000, UACJ 243. Basaseachic, Ocampo, on bark of *Cupressus arizonica*, *leg.* M. Lizárraga & J. Vargas, 6-V-2000, obtained from moist chamber cultura on 25-V-2000, UACJ 244, 245 and 246. Presa Casa de Adobe, Janos, on leaves of *Quercus* sp., *leg.* M. Lizárraga, 2-IX-2001, UACJ 242.

Observations: *Perichaena depressa* has been cited from Baja California, Baja California Sur, Morelos, Puebla, Sinaloa, Tlaxcala, Veracruz and Yucatán (ILLANA & *al.*, 2000).

***Perichaena vermicularis* (Schwein.) Rostaf.**

Material examined. Cusarare, Bachochi, on stems of *Quercus* sp., *leg.* M. Lizárraga, 11- VIII-2001, UACJ 252.

Observations: This species has been cited only from Baja California and Veracruz (ILLANA & *al.*, 2000).

***Physarum album* (Bull.) Cheval.**
=*P. nutans* Pers.

Material examined. Presa Casa de Adobe, Janos, on stems of Quercus sp., M. Lizárraga 2-IX-2001, UACJ 260.

Observations: *Physarum album* is a very abundant species in Mexico (ILLANA & *al.*, 2000).

***Physarum bitectum* G. Lister**

Material examined. San Juanito Bocoyna, on leaves of *Quercus crassifolia*, *leg.* M. Lizárraga & J. Vargas, 6-VIII-2000, UACJ 249. Presa Casa de Adobe, Janos, on leaves of *Quercus* sp., *leg.* M. Lizárraga, 2-IX-2001, UACJ 248.

Observations: The only previous records of this species are from Jalisco (KELLER & BRAUN, 1977) and Baja California (LIZÁRRAGA & *al.*, 1999).

***Physarum contextum* (Pers.) Pers.**

Material examined. Presa Casa de Adobe, Janos, on stems and leaves of *Quercus* sp., *leg.* M. Lizárraga, 2-IX-2001, UACJ 253.

Observations: This species has previously been cited only from Baja California by LIZÁRRAGA & *al.* (1999).

***Physarum decipiens* Curtis**

Material examined. Basaseachic, Ocampo, on bark of *Cupressus arizonica*, *leg.* M. Lizárraga & J. Vargas, 6-VI-2000, obtained from moist chamber cultura on 25-V-2000, UACJ 250 and 251.

Observations: *Physarum decipiens* is very near to or possibly conspecific with *Physarum auriscalpium* Cooke. The differences between these two taxa are very subjective according to the literature. We use the earlier name for our collections.

Physarum decipiens appears to be cited only from Tlaxcala by RODRÍGUEZ-PALMA & *al.* (2002).

***Physarum lateritium* (Berk. & Ravenel) Morgan**

Material examined. San Juanito Bocoyna, on needles of *Pinus arizonica*, leaves of *Quercus crassifolia* and *Arbutus* sp., *leg.* M. Lizárraga & J. Vargas, 6-VIII-2000, UACJ 254.

Observations: *Physarum lateritium* has been previously cited only from Baja California by MORENO & *al.* (2001).

***Physarum leucophaeum* Fr.**

Material examined. Patios de ICB-UACJ, Ciudad Juárez, Juárez, on bark of *Morus nigra*, *leg.* M. Lizárraga, obtained from moist chamber culture on 13-II-2000, UACJ 255.

Observations: This species has been cited from Chiapas, Nuevo León and Oaxaca by ILLANA & *al.* (2000) and from Baja California by MORENO & *al.* (2001).

***Physarum melleum* (Berk. & Broome) Massee**

Material examined. Presa Casa de Adobe, Janos, on leaves of *Quercus* sp., *leg.* M. Lizárraga, 2-IX-2001, UACJ 258 and 259.

Observations: *Physarum melleum* is also cited from Coahuila, Guerrero, Jalisco, Nuevo León, Sinaloa, Tlaxcala and Veracruz (ILLANA, & *al.*, 2000), and from Baja California by MORENO & *al.* (2001).

Physarum pusillum **(Berk. & M. A. Curtis) G. Lister**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, Ciudad Juárez, Juárez, tallos de *Larrea tridentata*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtenido de cultivo en cámara húmeda el 22-II-2000, UACJ 267. *Idem*, hojas de *Yuca elata*, 5-II-2000, UACJ 262. *Idem*, tallos de *Prosopis glandulosa*, UACJ 261 and 266. Sierra de Presidio, Samalayuca Juárez, tallos de *Larrea tridentata*, *leg.* M. Lizárraga, 8-II-2000, obtenido de cultivo en cámara húmeda el 9-II-20, UACJ 263 and 264. *Idem*, hojas de *Yuca* sp., 14-IV-2000, UACJ 265.

Observations: There are records from the Federal District, State of Mexico, Jalisco, Nuevo León and Veracruz (ILLANA, & *al.*, 2000), and from Baja California (MORENO & *al.*, 2001).

Physarum straminipes **Lister**

Material examined. Sierra Presidio, Samalayuca Juárez, on leaves of *Yucca* sp., *leg.* M. Lizárraga, 8-II-2000, obtained from moist chamber cultures on 8-IV-2000, UACJ 277. Presa Casa de Adobe, Janos, on stems of *Quercus* sp., *leg.* M. Lizárraga 2-IX-2001, UACJ 268.

Observations: Previously cited only from Baja California by LIZÁRRAGA & *al.* (1997).

Physarum viride **(Bull.) Pers.**

Material examined. San Juanito Bocoyna, on leaves of *Quercus crassifolia*, *leg.* M. Lizárraga & J. Vargas, 6-VIII-2000, UACJ 278. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg.* M. Lizárraga, 10-VIII-2000, UACJ 302 and 318.

Observations: This species is known only from the State of Mexico, Guerrero, Nuevo León, Quintana Roo, Tlaxcala and Veracruz (ILLANA, & *al.*, 2000).

The specimens UACJ 302 and 318 have sporothecae with greyish tones and a capillitium with orangeish nodules. This places them near to *Physarum viride* var. *incanum* Lister. This variety has been cited from Baja California by LIZÁRRAGA & al. (1999).

Physarum viride var. *viride* appears cited from the State of Mexico, Guerrero, Nuevo León, Quintana Roo, Tlaxcala and Veracruz, according to ILLANA, & *al.* (2000).

Protophysarum phloiogenum **Blackw. & Alexop.**

Material examined. Carretera Ciudad Juárez-Chihuahua km 10, Ciudad. Juárez, Juárez, on ítems of *Larrea tridentata*, *leg.* M. Lizárraga & R. Rivas, 17-I-2000, obtained from moist chamber cultura on 27-I-2000, UACJ 279. *Idem*, on stems of *Atriplex phoenensis*, 1-II-20 UACJ 280. *Idem*, on leaves of *Yuca elata*, 27-I-20, UACJ 281. Patios de ICB-UACJ, Ciudad Juárez, Juárez, on bark of *Ulmus americana*, obtained from moist chamber cultura on 5-II-2001, UACJ 282.

Observations: This species was previously known only from Baja California (MORENO & *al.*, 2001).

***Reticularia lycoperdon* Bull.**

Material examined. Delicias, *leg*. A. Piñon V., 10-X-2000, UACJ 342.

Observations: *Reticularia lycoperdon* has been cited from Baja California, State of Mexico, Jalisco, Nuevo León, Tlaxcala and Veracruz (ILLANA & *al*., 2000).

***Stemonitis fusca* Roth**

Material examined. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg*. M. Lizárraga, 10-VIII-2002, UACJ 319.

Observations: Very abundant in Mexico (ILLANA & *al*., 2000).

***Stemonitis splendens* Rostaf.**

Material examined. Cuiteco, Chihuahua, on decomposing wood, *leg*. M. Quiñónez & D. Beltrán, 8-X-2000, UACJ 283.

Observations: *Stemonitis splendens* is a very common species in Mexico (ILLANA & *al*., 2000).

***Stemonitopsis typhina* (F. H. Wigg.) Nann.-Bremek.**

Material examined. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg*. M. Lizárraga, 10-VIII-2000, UACJ 292 and 303.

Observations: This is a species frequently found in Mexico (ILLANA & *al*., 2000).

***Trichia persimilis* P. Karst. (Figs. 17-18)**

Material examined. Basaseachic, Ocampo, on bark of *Quercus* sp., *leg*. M. Lizárraga, 10-VIII-2002, UACJ 324, 327 and 340 in AH 31704.

Observations: The main microscopic characters of *Trichia persimilis* are the 4-6 µm diam. elaters with spinulose spiral bands and spores with an incomplete reticulum that sometimes breaks into patches. In the upper part of this ornamentation there is a second reticulum consisting of irregular small meshes (Fig. 18). When a subreticulum can be observed there sometimes appears a smaller patch of subreticulate to reticulate ornamentation in the zones without ornamentation. *T. affinis* de Bary has a smooth capillitium of 5-6 µm diam. and spores with a broad-meshed complete reticulum (PÉREZ-SILVA & *al*., 2001).

FARR (1958) and MARTIN & ALEXOPOULOS (1969) considered these two taxa to represent one variable species. Others authors such as NANNENGA-BREMEKAMP (1991) and LADO & PANDO (1997) recognize three species within the *Trichia favoginea* complex. All the Chihuahuan collections are for the moment determined as *T. persimilis*. This is a new record for Mexico.

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REFERENCES

BRAUN, K. L. & H.W. KELLER (1976). Myxomycetes of Mexico. I. *Mycotaxon* 3: 297-317.

BRAUN, K. L. & H.W. KELLER (1986). Myxomycetes of Mexico. III. *Revista Mex. Micol.* 2: 25-39.

CASTILLO, A., C. ILLANA & G. MORENO (1996*). Badhamia melanospora* Speg. A species wrongly interpreted. *Mycotaxon* 57: 163-170.

DHILLON, S.S. & N.E. NANNENGA-BREMEKAMP (1978). Notes on some Myxomycetes from the North-Western part of the Himalaya. Kon. Ned. Akad. Wetensch., C 78: 141-149.

ESTRADA-TORRES, A., J. M. RAMÍREZ-ORTEGA& C. LADO. (2003). *Calonema foliicola* a new myxomycete from Mexico. Mycologia, 95: 354-359.

FARR, M.L. 1958. Taxonomic studies in the Myxomycetes I.. The *Trichia favoginea* complex. *Mycologia* 50: 357-369.

ILLANA, C., G. MORENO &. M. LIZÁRRAGA (2000). Catálogo de Myxomycetes de México. *Stapfia* 73: 167-186.

KELLER, H.W. & K. L. BRAUN (1977). Myxomycetes of Mexico. II. *Bol. Soc. Méx. Micol.*. 11 167-180.

KELLER, H.W., U. ELIASSON, K. L. BRAUN & M. J. BUBEN-ZUREY (1988). Corticolous Myxomycetes X: Ultrastructure and taxonomic status of *Cribraria minutissima* and *C. confusa*. *Mycologia* 80: 536-545.

LADO, C. (2001). *Cuadernos de trabajo de Flora Micológica Ibérica 16. Nomenmyx, a nomenclatural taxabase of Myxomycetes.* Consejo superior de investigaciones científicas Real Jardín Botánico, Madrid.

LADO, C. & L. PANDO (1997). *Flora Mycologica Iberica. Vol. 2. Myxomycetes, I. Ceratiomyxales, Echinosteliales, Liceales, Trichiales.* Madrid. Real Jardín Botánico, Königstein. Cramer in Koeltz.

LIZÁRRAGA, M. (2002). Myxomycetes de Chihuahua I. In G. GUZMÁN & G. MATA (ed.). *Estudio taxonómico de hongos macromicetos en el norte de Sinaloa, México. Estudios sobre los hongos latinoamericanos.* Resúmenes del IV Congreso Latinoamericano de Micologia. pág. 250. Xalapa, Veracruz.

LIZÁRRAGA, M., C. ILLANA, & G. MORENO (1997). The Myxomycetes from Baja California (México). I. *Mycotaxon* 63: 287-300.

LIZÁRRAGA, M., C. ILLANA & G. MORENO (1999). SEM studies of the Myxomycetes from Peninsula of Baja California (Mexico), II. *Hemitrichia* to *Trichia. Ann. Bot. Fennici* 36: 187-210.

LIZÁRRAGA, M., G. MORENO & C. ILLANA. (1998). First records of Myxomycetes in the state of Sinaloa, México. *Micol. Veg. Medit.* 13: 167-176.

MARTIN, G. W. & C. J. ALEXOPOULOUS (1969). *The Myxomycetes.* University of Iowa Press. Iowa City. 561 pp.

MORENO, G., C. ILLANA & M. LIZÁRRAGA (2001). SEM studies of the Myxomycetes from the Peninsula of Baja California (Mexico), III. Additions. *Ann. Bot. Fennici* 38: 225-247.

MORENO, G., A. SÁNCHEZ, H. SINGER, C. ILLANA & A. CASTILLO (2002). A study on nivicolous Myxomycetes. The genus *Lamproderma* I. *Fungi non delineati* 19: 1-66.

NANNENGA-BREMEKAMP, N.E. 1991. *A guide to temperate Myxomycetes.* Biopress Limited, Bristol.

NANNENGA-BREMEKAMP, N.E. & Y. YAMAMOTO (1983). Additions to the Myxomycetes of Japan. I. Kon. Ned. Akad. Wetensch., C 86: 207-241.

PÉREZ-SILVA, E., T. HERRERA, M. ESQUEDA, C. ILLANA & G. MORENO (2001). Myxomycetes of Sonora, Mexico. I. *Mycotaxon* 77: 181-192.

QUIÑÓNES M. M., O. F. GARZA, F. J. R. MENDOZA, J. J.GARCÍA, A. J. SÁENS & H. G. BOLAÑOS (1999). *Guía de hongos de la región de Bosque Modelo Chihuahua.* Facultad de Zootecnia, Universidad Autónoma de Chihuahua.

RODRÍGUEZ-PALMA, M., A. VARELA-GARCÍA & C. LADO (2002) Corticolous Myxomycetes associated with four tree species in México. *Mycotaxon* 81: 345-355.

RZEDOWSKI, J. (1994). *Vegetación de México.* Ed. Limusa, México. 432 pp.

WHITNEY K.D. (1980). The Myxomycetes genus *Echinostelium*. Mycologia 72: 950-987.

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MYXOMYCETES IN THE STATE OF SINALOA, (MEXICO) II.

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ABSTRACT: 19 species of Myxomycetes collected in Sinaloa (Mexico) are cited, 9 of which are new records for Sinaloa. *Physarum dictyosporum* is a new record for Mexico. *Hemitrichia parviverrucospora* is an autonomous species, different from *H. serpula*. We give SEM micrographs of the problematic taxa.

KEY WORDS: chorology, Myxomycota, scanning electron microscopy, taxonomy

INTRODUCTION

This work presents the continuation of the studies about Myxomycetes of the state of Sinaloa (Mexico), initiated by LIZÁRRAGA & *al.* (1998), where 17 taxa were cited.

Later on, the only known records are the ones indicated in the summary published in the minute book of the IV Latin-American congress of mycology by QUIÑ ONES & BELTRÁN (2002), where they cite four Myxomycetes from Sinaloa (*Lycogala epidendrum, Badhamia foliicola, Fuligo septica* and *Stemonitis splendens*).

The state of Sinaloa, with an area of 5.858.092 km^2, is situated in the north-west of Mexico. Its vegetation is formed by matorral with elements of the arid zones (sarcocaulous matorral), low caducifolious forest with arboreal elements of 4-15 m in height and deciduous trees which lose their leaves in the dry period of the year. In mountainous areas a temperate forest with pine-oak can be found. The average, temperature for the state is 25 °C, with a variable climatology, being hot, temperate hot, temperate cold and cold depending on the coastal border, the valleys and the sides of the slopes There are small mountains up to 400 m, the highest mountains range between 1500 and 3000 m.

MATERIAL AND METHODS

The studied material was collected during the month of January of 2001, in the case of a different date this is indicated. The material was mounted in Hoyer's medium and studied with a Nikon Labophot microscope. Photographs of spores and capillitium (critical point dried material), were taken with a Zeiss-DSM 950 microscope. The descriptions of spore wall ornamentation follows the terminology proposed by RAMMELOO (1974, 1975, 1981).

Some species that are not illustrated in this paper with SEM photographs were already published for the states of Baja California and Sinaloa in Mexico by LIZÁRRAGA *& al.* (1997, 1998, 1999a, 1999b) and MORENO *& al.* (2001).

The specimens are deposited in the herbarium UACJ of the departement "Ciencias Básicas" of the university "Autónoma de Ciudad Juárez" (Mexico), a duplicate of rare species or species new for Mexico are deposited in the herbarium AH of the departement of "Biología Vegetal (Botánica)" in the university of "Alcalá de Henares" (Spain).

LIST OF SPECIES

***Arcyria affinis* Rostaf.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, UACJ 355, 356 and 357.

This species is cited from Sinaloa (LIZÁRRAGA *& al.*, 1998) and Baja California (LIZÁRRAGA *& al.*, 1999a).

***Arcyria cinerea* (Bull.) Pers.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, UACJ 358, 359 and 360.

This is a very abundant species in Mexico (ILLANA *& al.*, 2000).

***Arcyria obvelata* (Oeder) Onsberg**

= *A. nutans* (Bull.) Grev.

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, UACJ 361.

This is a very common species in Mexico (ILLANA *& al.*, 2000), but it is the first record for Sinaloa.

***Badhamia gracilis* (T. Macbr.) T. Macbr.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on cladode of *Opuntia* sp., *leg.* M. Lizárraga & E. Lizárraga, UACJ 362 and 363.

This is a species that fructifies frequentely on residues of succulent plants, mainly from the family Cactaceae. Nevertheless, there are only a few records from Mexico, according to ILLANA *& al.* (2000). This is the first record for Sinaloa.

***Badhamia utricularis* (Bull.) Berk.**

Material examined. Presa Colosio, Choix, on bryophytes, *leg.* M. Quiñones & F. Cantú, 15-VII-2000, UACJ 364.

This is a species that is cited only from the state of Mexico by BRAUN & KELLER (1976). It is a new record for Sinaloa.

***Clastoderma debaryanum* A. Blytt.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, 6-I-2001, obtained in moist chamber on 30-I-2001, UACJ 365.

This species was cited from Jalisco, Quintana Roo, Veracruz, according to the compilation of ILLANA & *al.* (2000). It was reported from Sinaloa by LIZÁRRAGA & *al.* (1998).

***Dictydiaethalium plumbeum* (Schumach.) Rostaf.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 367.

This species was cited from Baja California, Nuevo León, Querétaro and Veracruz (ILLANA & *al.*, 2000). This is a new record for Sinaloa.

***Fuligo septica* (L.) F. H. Wigg.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 368 and 369.

This is a very abundant species in Mexico (ILLANA & *al.*, 2000); it was cited from Sinaloa by QUIÑONES & BELTRAN (2002).

***Hemitrichia parviverrucospora* (Lizárraga, G. Moreno & Illana) G. Moreno & Illana (Figs. 1, 3, 5)**

≡ *H. serpula* var. *parviverrucospora* Lizárraga, G. Moreno & Illana, *Ann. Bot. Fennici* 36: 189. 1999.

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 370, slide AH 19900. *Hemitrichia serpula*, Chihuahua, Basaseachic, Ocampo, on twigs of *Quercus* sp., *leg*. M. Lizárraga, 4-X-2002, UACJ 296, slide AH 19899.

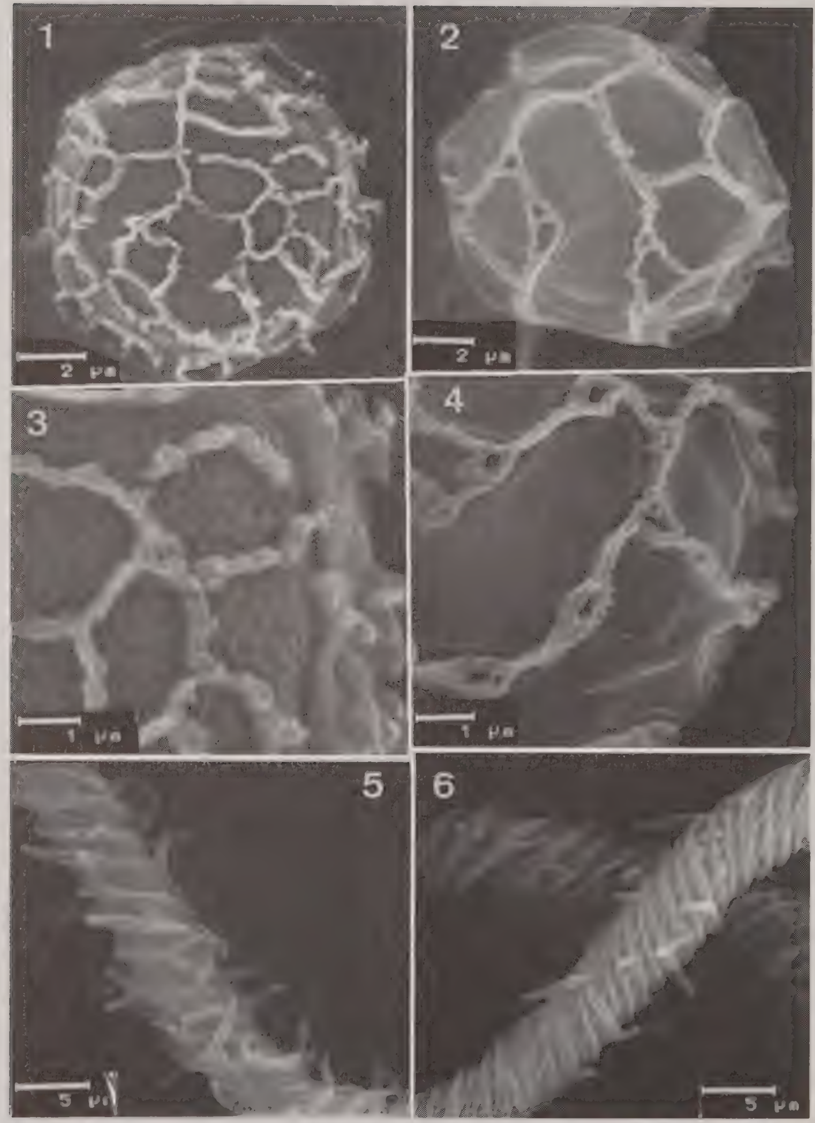
Hemitrichia parviverrucospora was described as a variety of *H. serpula* (LIZARRAGA & *al.*, 1999b) and afterwards combined to species in the work of PÉREZ-SILVA & *al.* (2001). Nevertheless, recently LADO (2001) treated it as a synonym of *H. serpula.*

Although the two taxa are macroscopically identical, we distinguish them easily by the light microscope. *Hemitrichia parviverrucospora* is characterized by the capillitium with spiral bands bearing abundant spines, 4-7 µm long, (Fig. 5). By SEM the spores are reticulate and bear small warts within the meshes, being clearly visible (Figs. 1, 3). Nevertheless, *H. serpula* (Scop.) Rostaf. is distinguished by its capillitium with spiral bands bearing fewer spines, these being shorter (rarely more than 3-5 µm long) (Fig. 6). By SEM the spores are reticulate without warts within the meshes (Figs. 2, 4).

Up to the present time *Hemitrichia parviverrucospora* and *H. serpula* have never been found growing together.

Hemitrichia parviverrucospora, together with *Metatrichia horrida* and *Physarella oblonga* present a climatic distribution ranging from tropical to subtropical. *H. serpula* prefers a temperate climate.

Hemitrichia parviverrucospora has been cited from central Africa by RAMMELOO (1981) and Mexico from Baja California Sur and Sinaloa by Lizárraga *et al.* (1998, 1999b).



Figs. 1, 3 and 5. ***Hemitrichia parviverrucospora*** **(UACJ 370):** 1. Spore. 3. Detail of spore ornamentation. 5. Capillitium with abundant and large spines. **Figs. 2, 4 and 6.** ***Hemitrichia serpula*** **(UACJ 296):** 2. Spore. 4. Detail of spore ornamentation. 6. Capillitium with few and short spines.

Lycogala epidendrum **(L.) Fr.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 372 and 373.

This is an abundant species in Mexico (ILLANA & *al*., 2000), cited from Sinaloa by QUIÑONES & BELTRAN (2002).

Metatrichia horrida **Ing**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 118 and 227.

This African species was cited for the first time on the American continent from Mexico, Baja California Sur by Moreno & *al*. (1997), from Sinaloa by Lizárraga & *al*. (1998) and, more recently from the state of Sonora by Pérez-Silva & *al*. (2001). Recently, it was cited from Cuba by WRIGLEY de BASANTA & *al*. (2003).

In Sinaloa *Metatrichia horrida* is a very common species. Nevertheless, the ubiquitous species *M. vesparia* (Batsch) Nann.-Bremek. has not yet been reported.

Perichaena chrysosperma **(Curr.) Lister**

Material examined. Cerro de las 7 gotas, El Barrio, Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 374.

This is a frequent species in Mexico (ILLANA & *al*., 2000), reported from Sinaloa by LIZÁRRAGA & *al*. (1998).

Perichaena corticalis **(Batsch) Rostaf.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on cladodes of *Opuntia* sp., *leg*. M. Lizárraga & E. Lizárraga, UACJ 375 and 376. *Idem*, 6-I-2001, obtained in moist chamber on 30-I-2001, UACJ 377 and 378.

Perichaena corticalis shows a profound macroscopical similarity with *Trichia agaves* (G. Moreno, Lizárraga & Illana) Mosquera, Lado, Estrada & Beltrán-Tej., a species recently described (MORENO & *al*., 2000; LADO, 2001), that is common on succulent plants of the families Cactaceae and some Liliaceae of the genus *Agave*

This is the first time that we have collected *Perichaena corticalis* on residues of *Opuntia* sp. This species, although cosmopolitan, is rarely cited from Mexico. We know records only from Tlaxcala made by GALINDO-FLORES (1993) and RODRÍGUEZ-PALMA & *al*. (2002), from Chihuahua by LIZÁRRAGA (2002) and from Quintana Roo by ANDRADE-TORRES & *al*. (2002).

Perichaena depressa **Lib.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing Word, *leg*. M. Lizárraga & E. Lizárraga, UACJ 389.

This is a species commonly reported from Mexico (ILLANA & *al*., 2000). It was already cited for Sinaloa by LIZÁRRAGA & *al*. (1998).

Physarella oblonga **(Berk. & M. A. Curtis) Morgan.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 390 and 379.

This species was cited from Chiapas, Quintana Roo, Sinaloa and Veracruz, according to the bibliographic compilation of ILLANA & *al*. (2000). Before, it was reported from Sinaloa by LIZÁRRAGA & *al*. (1998). *Physarella oblonga* has a mainly tropical distribution.

Physarum bitectum **G. Lister**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg*. M. Lizárraga & E. Lizárraga, UACJ 380.

Physarum bitectum was previously cited from Jalisco by KELLER & BRAUN (1977), from Baja California by LIZÁRRAGA & *al.* (1999b) and from Chihuahua by LIZÁRRAGA (2002). This represents the first record for Sinaloa.

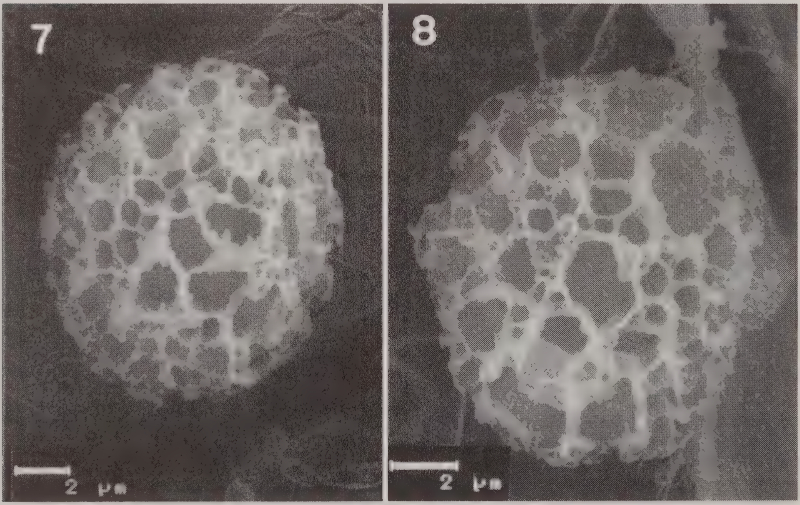
***Physarum dictyosporum* G. W. Martin (Figs. 7-8)**

Material examined. Cerro de las siete gotas, El Barrio, Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, 27-III-2002, AH 19698, slide UACJ 354.

Plasmodiocarpous to sporocarpous fructifications, sessile, elongated to sinuous, 0.5-3 mm long, more rarely globose, 0.2-0.4 mm in diam. Peridium double, the outer layer white, crusty, formed by calcium carbonate, inner layer membranous, very tenuous, hyaline, iridescent.

Capillitium formed by slender filaments, hyaline, with rounded whitish nodes of calcium carbonate. Spores 10-12 µm in diam., including ornamentation, globose, irregularly reticulate, with walls up to 2 µm, black in mass, dark violaceous with a paler lateral zone as seen by the optical microscope. By SEM the ornamentation is reticulate with meshes of variable diameter and walls with a reticulum formed by small superficial meshes (Figs. 7-8).

Physarum dictyospermum Lister & G. Lister can easily be distinguished from *P.dictyosporum*, because the first species is stalked and has orange-brown to olivaceous



Figs. 7-8. ***Physarum dictyosporum* (AH 19698):** 1-2. Spores with reticulate spore ornamentation.

-brown sporothecae (LISTER, 1925; MARTIN & ALEXOPOULOS, 1969).

Physarum echinosporum Lister differs from *P. dictyosporum* by its laterally compressed sporocarps which are very similar to those of *P. bivalve* and subreticulate spores (LISTER, 1925). This is a new record for México.

***Physarum leucophaum* Fr.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, UACJ 385.

Physarum leucophaum appears to be uncommon in México. It is known only from the states of Baja California, Chiapas, Nuevo León and Oaxaca, according to the compilation of ILLANA *& al.* (2000), and from Chihuahua by LIZÁRRAGA (2002). This is a new record for Sinaloa.

***Stemonitopsis typhina* (F. H. Wigg.) Nann.-Bremek.**

Material examined. Cerro de las 7 gotas, El Barrio Culiacán, on decomposing wood, *leg.* M. Lizárraga & E. Lizárraga, UACJ 386, 387 and 388.

This species was cited from Chiapas, Jalisco, Nuevo León, Puebla, Quintana Roo and Veracruz, according to the bibliographic compilation of ILLANA *& al.* (2000). This is a new record for Sinaloa.

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BIBLIOGRAPHY

ANDRADE-TORRES, A., E.A. MEZA-HERNÁNDEZ & C. CUEVAS-SUÁREZ (2002). Los Myxomycetes del estado de Quintana Roo, México. In G. GUZMÁN & G. MATA (eds.). *Estudio taxonómico de hongos macromicetos en el norte de Sinaloa, México. Estudios sobre los hongos latinoamericanos*. Resúmenes del IV Congreso Latinoamericano de Micología. pág. 252. Xalapa, Veracruz.

BRAUN, K. L. & H. W. KELLER (1976). Myxomycetes of Mexico. I. *Mycotaxon* 3: 297-317.

GALINDO-FLORES, G. (1993). *Estudio taxonómico y biogeográfico de las especies de la familia Trichiaceae (Trichiales-Myxomycetes) que se desarrollan en el estado de Tlaxcala*. Tesis de Licenciatura. ENEP Iztacala, UNAM. Tlalnepantla.

ILLANA, C., G. MORENO & M. LIZÁRRAGA. (2000) Catálogo de Myxomycetes de México. *Stapfia* 73: 167-186.

KELLER, H. W. & K. L. BRAUN (1977). Myxomycetes of Mexico. II. *Bol. Soc. Mex. Micol.* 11: 167-180.

LADO, C., (2001). Nomenmyx, a nomenclatural taxabase of Myxomycetes. *Cuad. Trab. Fl. Micol. Ibér.* 16: 1-220.

LISTER, A., (1925). *A monograph of the Mycetozoa*. Ed. 3, "revised by G. LISTER". Reprinted by permission of the Trustees of the British Museum. London: British Museum, 222 p.

LIZÁRRAGA, M. (2002). Myxomycetes de Chihuahua I. In G. GUZMÁN & G. MATA (ed.). *Estudio taxonómico de hongos macromicetos en el norte de Sinaloa, México. Estudios sobre los hongos latinoamericanos*. Resúmenes del IV Congreso Latinoamericano de Micología. pág. 250. Xalapa, Veracruz.

LIZÁRRAGA, M., G. MORENO & C. ILLANA (1997). The Myxomycetes from Baja California (Mexico). I. *Mycotaxon* 63: 287-300

LIZÁRRAGA, M., C. ILLANA & G. MORENO (1999a). SEM studies of the Myxomycetes from the Peninsula of Baja California (Mexico), I. *Arcyria* to *Fuligo*. *Ann. Bot. Fennici* 35: 287-306.

LIZÁRRAGA, M., C. ILLANA & G. MORENO (1999b). SEM studies of the Myxomycetes from Peninsula of Baja California (Mexico), II. *Hemitrichia* to *Trichia*. *Ann. Bot. Fennici* 36: 187-210.

LIZÁRRAGA, M., G. MORENO & C. ILLANA. (1998). First records of Myxomycetes in the state of Sinaloa, México. *Micol. Veg. Medit.* 13: 167-176.

MARTIN, G. W. & C. J. ALEXOPOULOS (1969). *The Myxomycetes*. University of Iowa Press. Iowa City. 561 pp.

MORENO, G., M. LIZÁRRAGA & C. ILLANA (1997). *Metatrichia horrida* (Myxomycetes), an African species in the Baja California Peninsula (Mexico). *Mycotaxon* 64: 385-392.

MORENO, G., C. ILLANA & M. LIZÁRRAGA (2001). SEM studies of the Myxomycetes from the Peninsula of Baja California (Mexico), III. Additions. *Ann. Bot. Fennici* 38: 225-247.

MORENO, G., M. LIZÁRRAGA, C. ILLANA, A. CASTILLO & M. OLTRA (2000). *Hemitrichia agaves* sp. nov. un nuovo Myxomycetes delle piante grasse dal Messico e dalla Spagna. *RdM* 1: 5-16.

PÉREZ-SILVA, E., T. HERRERA, M. ESQUEDA, C. ILLANA & G. MORENO. (2001). Myxomycetes of Sonora, Mexico. I. *Mycotaxon* 77: 181-192.

QUIÑONES, M. & D. BELTRÁN (2002). In G. GUZMÁN & G. MATA (ed.). *Estudio taxonómico de hongos macromicetos en el norte de Sinaloa, México. Estudios sobre los hongos latinoamericanos*. Resúmenes del IV Congreso Latinoamericano de Micología. pág. 239. Xalapa, Veracruz.

RAMMELOO J., (1974). Structure of the epispore in the Trichiaceae (Trichiales, Myxomycetes) as seen with the scanning electron microscope. *Bull. Soc. Roy. Bot. Belgique*. 107: 353-359.

RAMMELOO, J. (1975). Structure of the epispore in the Stemonitales (Myxomycetes) as seen with the scanning electron microscope. *Bull. Jard. Bot. Belg*. 45: 301-306.

RAMMELOO, J. (1981). Trichiales (Myxomycetes). In: *Flore illustrée des champignons d'Afrique Centrale, fascicules* 8-9: 135-169. Ministère de l'Agriculture, Jardin Bototanique National Belgique, Meise.

RODRÍGUEZ-PALMA, M., A. VARELA-GARCÍA & C. LADO (2002) Corticolous Myxomycetes associated with four tree species in México. *Mycotaxon* 81: 345-355.

WRIGLEY de BASANTA, D., A. ESTRADA-TORRES & C. LADO (2003). Biodiversity surveys for Neotropical Mycetozoans in Cuba and Mexico. *Inoculum* 54: 1-2.

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FIRST RECORD OF TERMITOMYCES ENTOLOMOIDES IN CHINA

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ABSTRACT

The first record of *Termitomyces entolomoides* in China is reported from Guangdong Province, based on a field collection. The species is characterized by a black pileus and a swollen stipe at ground level, being of medium size within the genus. This is the fifth record of the species in Asia after it was first described in 1952 from Africa. This paper provides a full description of the new record, compared with the other three collections from Southeast Asia. The differences between this species and its related species are also discussed.

Key words: termite mushroom, distribution

中文摘要

本文报道了在广东发现的中国蚁巢伞属一新记录—黑盖蚁巢伞。黑盖蚁巢伞以黑色的菌盖和在近地面处膨大的菌柄为主要特征。本文对这一新记录进行了全面描述，并与产自东南亚的3份黑盖蚁巢伞标本进行了比较，同时还讨论了该种与其近似种类的区别。这一报道是该种自1952年从非洲描述后在亚洲的第五次记录。

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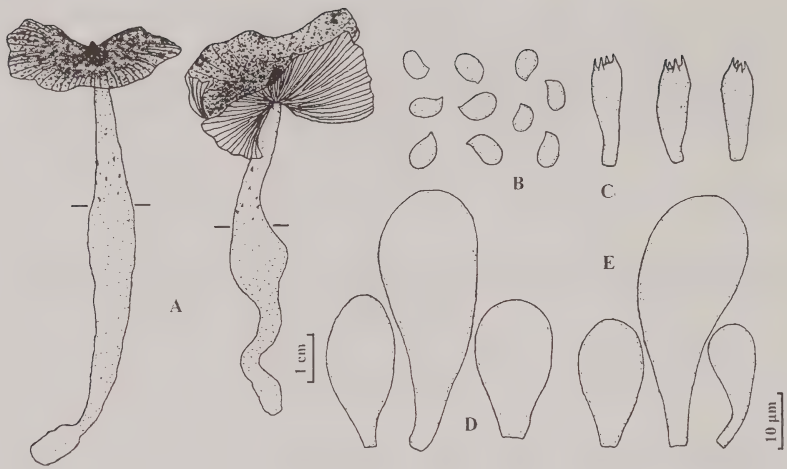

Fig. 1. *Termitomyces entolomoides* (HMIGD11367): A. habit; B. basidiospores; C. basidia; D. cheilocystidia; E. pleurocystidia.

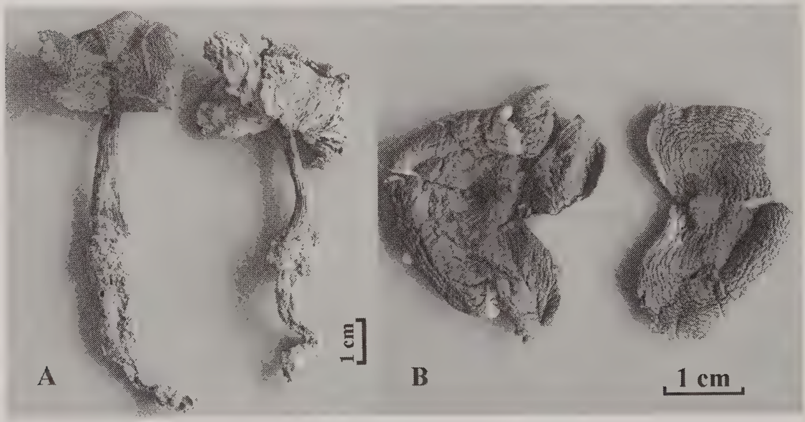

Fig. 2. Basidiosporocarps of *Termitomyces entolomoides*. A. The collection from Guangdong, China (HMIGD11367); B. The collection from Singapore, pilea only (KM109534).

INTRODUCTION

Termitomyces R. Heim 1942 was introduced for a group of high-priced edible agarics, which grow within the nests of termite species of the *Macrotermitinae* (*Isoptera*) (Heim 1977, Batra & Batra 1979, Bels & Pataragetvit 1982), and was placed by Singer (1986) in *Tricholomataceae* R. Heim ex Pouzar 1983. According to the *Index of Fungi*, there are 53 names published in *Termitomyces*, and species of the genus are found in equatorial, South Africa and South Asia (Pegler & Vanhaecke 1994). In China, *Termitomyces* species are mainly distributed to the south of the Yangtze River (Teng 1963, Zang 1981, Mao 2000, Wei & Yao 2003) in the subtropical or tropical regions with a warm and humid climate. Twenty-four taxa of the genus, including three new species, *T. albiceps* S. C. He 1985, *T. cylindricus* S. C. He 1985 and *T. macrocarpus* Z. F. Zhang & X. Y. Ruan 1986, have been reported in 17 provinces (Wei & Yao 2003). Among these records, 13 taxa were supported by cited specimens and 9 records lack the support of specimens (Wei & Yao 2003).

In a study of *Termitomyces* in Guangdong Province, a collection was found to represent *T. entolomoides* R. Heim 1952, a species originally described from Africa (Heim 1952) and found in Southeast Asia for only a few times (Pegler & Vanhaecke 1994, Turnbull & Watling 1999). The collection was compared with the other three specimens from Southeast Asia previously cited in Pegler & Vanhaecke (1994) and proved to be the first record of the species in China. This paper provides a full description of the Chinese record with a discussion of related species.

TAXONOMY

Termitomyces entolomoides R. Heim in *Denkschr. Schweiz. Naturf. Ges.* 80: 23 (1952). Figs 1, 2A.

Pileus 3.5–4.0 cm diam., plano-convex to uplifted at last, with a small, sharply pointed perforatorium; surface black at center, elsewhere grayish black, slightly paling towards the margin, smooth, glabrous, striate radially; margin straight or uplifted, splitting. *Lamellae* free, white to pinkish, 3.0–4.0 mm wide, densely crowded, with lamellulae. *Stipe* 4.5–5.0 cm long above ground, 0.5–0.7 cm thick close to apex, cylindrical, but swollen at ground level, solid, fibrous; surface pale gray, with small floccules. *Annulus* absent. *Pseudorhiza* 4.0–5.5 cm long, 1.5–1.7 cm thick close to ground level, tapering, with a white, cylindrical terminal connected with termite nest; surface gray, with longitudinal grooves. *Context* white, fleshy, thin, comprising repent, thin-walled hyphae, 3.0–7.0 μm diam, inflating to 35 μm diam. *Spore deposit* pink. *Basidiospores* 5.5–7.0 × 3.5–4.5 μm, ovoid to ellipsoid, subhyaline, thin-walled. *Basidia* 17.0–22 × 6.0–7.0 μm, clavate, bearing four sterigmata, subhyaline. *Hymenophoral trama* regular, 60–80 μm wide, with hyaline hyphae, 5.0–20 μm diam. *Subhymenial layer* 8.0–10.0 μm wide, consisting of repent hyphae, 2.0–5.0 μm diam. *Lamella-edge* heteromorphous. *Cheilocystidia* clavate to pyriform, 28–60 × 13.0–31 μm, thin-walled, hyaline. *Pleurocystidia* rare, clavate to pyriform, 23–41 × 9.0–26 μm, thin-walled, hyaline. *Pileipellis* a repent epicutis of narrow, radial hyphae with yellowish vacuolar pigment, 3.0–5.0 μm diam.

Specimens examined: China: Guangdong Province, Huidong County, Gutian, 400 m alt., on ground in broadleaf woodland, 11 July 1987, G. -Y. Zheng, HMIGD11367; Malaysia: Selanger, Serdang, on termite mound of *Macrtermes gilvus*, 14 July 1990, M. Vanhaecke T10, K(M)16520; Kepong, March 1974, H. L. Thong FP184, K(M)94651; Singapore: Botanic Garden, 9 Dec. 1979, V. Demoulin 5496, K(M)109534. The above description is solely based on the Chinese collection. The other specimens from Malaysia and Singapore were examined for the purpose of comparison.

Distribution: Africa: Zaire (now as Congo, Heim 1952, 1977); Asia: China (this report), Malaysia (Pegler & Vanhaecke 1994, Turnbull & Watling, 1999), Singapore (Pegler & Vanhaecke 1994).

DISCUSSION

Termitomyces entolomoides was originally described on the basis of material from Congo (formerly Zaire or Democratic Republic of Congo), and is not reported elsewhere in Africa. In Asia, it was reported only by Pegler & Vanhaecke (1994) and Turnbull & Watling (1999) from Malaysia and Singapore. The discovery of this species in China expands its distribution to the subtropic zone in the northern hemisphere. However, the species may not be rare as currently recorded around the world. There may be additional distribution of the species in Southeast Asia and in South China. The fungus is associated with *Macrotermes gilvus* Hagen in Malaysia (Pegler & Vanhaecke 1994), and detailed biological discussion was provided by Heim (1977).

Termitomyces entolomoides is one of the medium-sized species of the genus. Its pileus is up to only 7 cm diam. (Pegler & Vanhaecke 1994). Furthermore, the species is also characterized by glabrous, blackish pileus surface; non-annulate, swollen stipe and small spores. For comparison, the specimen from Singapore is also photographed in Fig. 2B. Compared with the three collections from Malaysia and Singapore, the Chinese collection shows a strong resemblance macromorphologically and microscopically except for the size of cheilocystidia, which is larger than that of the collections from Southeast Asia measured as 18.0–25 × 9.0–12.0 µm by the present authors. The size of basidia was recorded as '22–35 × 7–8 µm' in Pegler & Vanhaecke (1994) for the Malaysian and Singapore material, but according to the observations by the present authors, there is no significant difference in basidial size between the collections from China and from Southeast Asia.

Heim (1977) placed *T. entolomoides* within the stirpe *Striatus* with two medium-sized species of the genus, *T. aurantiacus* R. Heim 1977 and *T. striatus* (Beeli) R. Heim 1941. The Chinese collection can be distinguished from *T. aurantiacus*, which has a reddish ochraceus to orange pileus (Heim 1977, Pegler 1977, Pegler & Vanhaecke 1994), by its black pileus. The pileus colour of *T. striatus*, including the infraspecific taxa *T. striatus* var. *annulatus* R. Heim 1942, *T. striatus* f. *griseus* R. Heim 1958 and *T. striatus* f. *ochraceus* R. Heim 1958, often varies from grayish to ochraceus brown, but never changes to blackish (Heim 1977, Pegler 1977, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994).

Termitomyces sagittiformis (Kalchbr. & Cooke) Reid 1975 (Reid 1975, Van der Westhuizen & Eicker 1990) and *T. rabuorii* Otieno 1966 (Pegler 1977) may also be related to *T. entolomoides* on the basis of the sizes of basidioma. However, both species have a brown pileus surface and dark brown pseudorhiza differing from the black pileus and gray pseudorhiza in *T. entolomoides*. Furthermore, *T. sagittiformis* has larger basidiospores, 7.4–10.1 × 5.8–6.4 µm (Van der Westhuizen & Eicker 1990).

Some other medium-sized species in the genus, such as *T. clypeatus* R. Heim 1951, *T. cylindricus* and *T. spiniformis* R. Heim 1977, also have a coloured pileus and non-annulate stipe, but all of them are not blackish. The perforatorium of the Chinese collection is small and differs from the strongly spiniform perforatorium of *T. clypeatus* (Heim 1977, Pegler 1977, Van der Westhuizen & Eicker 1990, Pegler & Vanhaecke 1994, Turnbull & Watling 1999) and the long perforatorium of *T. spiniformis* (Heim 1977). *Termitomyces cylindricus* has a small pointed perforatorium, but the under part of its pseudorhiza is pale yellowish green (He 1985) compared with gray pseudorhiza of *T. entolomoides*.

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REFERENCES

Batra, L. R. & Batra, S. W. T. (1979). Termite-fungus mutualism. In Batra, L. R. *Insect-Fungus Symbiosis. Nutrition, Mutualism and Commensalis.* 117–163 pp. New York: Allanheld, Osmun & Co.

Bels, P. J. & Pataragetvit, S. (1982). Edible mushrooms in Thailand, cultivated by termites. In Zhang S T & Quimio T H. *Tropical Mushrooms Biological Nature and Cultivation Methods*. 445–461 pp. Hong Kong: The Chinese University Press.

Heim, R. (1942). Nouvelles études descriptives sur les agarics termitophiles d'Afrique tropicale. *Arch. Mus. Natl. Hist. Nat. sér.* 6, **18**: 1–60.

Heim, R. (1952). Les *Termitomyces* du Cameroun et du Congo français. *Denkschr. Schweiz. Naturf. Ges.* 80: 1–29.

Heim, R. (1977). *Termites et Champignons*. Paris: Société Nouvelle Des Éditions Boubée. 1–206 pp.

Mao, X. -L. (2000). *The Macrofungi in China*. Zhengzhou, China: Henan Science & Technology Press. 1–719 pp. (in Chinese).

Pegler, D. N. (1977). A preliminary agaric flora of East Africa. *Kew Bull. Add. Ser.*, **6**: 1–615.

Pegler, D. N. & Vanhaecke, M. (1994). *Termitomyces* of Southeast Asia. *Kew Bull.* **49**: 717–736.

Reid, D. A. (1975). Type studies of the larger *Basidiomycetes* described from Southern Africa. *Contribut. Bolus Herb.* **7**: 1–255.

Singer, R. (1986). The *Agaricales* in Mordern Taxonomy. Germany: Kenigstern. 1–980 pp.

Teng, S. -C. (1963). *Fungi of China*. Beijing: Science Press. 1–808 pp. (in Chinese).

Turnbull, E. & Watling, R. (1999). Some records of *Termitomyces* from old world rainforests. *Kew Bull.* **54**: 731–738.

Van Der Westhuizen, G. C. A. & Eicker, A. (1990). Species of *Termitomyces* occurring in South Africa. *Mycol. Res.* **94**: 923–937.

Wei, T. -Z. & Yao, Y. -J. (2003). Literature review of *Termitomyces* species in China. *Fung. Sci.* **22**: in press (in Chinese).

Zang, M. (1981) Notes on the classification and distribution of *Termitomyces* from Yunnan. *Acta Bot. Yunnanica* **3**: 367–374. (in Chinese).

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A NEW SPECIES OF BOLETUS FROM GANSU PROVINCE, CHINA

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ABSTRACT

A new species from Gansu Province of China, *Boletus gansunensis*, is described and illustrated. The species is characterised by a pale red to pastel red pileus; pinkish red small pores; and purplish red to dark purplish red and slightly furfuraceous stipe. The distinctions between *B. gansunensis* and the related species *B. barragensis, B. magnificus*, *B. prolinus*, *B. queletii* and *B. subvelutipes* are also discussed.

Key words: Basidiomycetes, *Boletales*, *Boletus* sect. *Luridi*

中文摘要

本文对在中国甘肃省发现的牛肝菌属一新种—甘肃牛肝菌(*Boletus gansunensis*) 进行了全面的描述，并附有图示。甘肃牛肝菌以其淡红至粉红的菌盖，粉红色且较小的孔口，以及紫红色至暗紫红色、稍具软鳞片的菌柄为特征。本文就甘肃牛肝菌与其近缘种 *B. barragensi*、*B. magnificus* (华丽牛肝菌)、*B. queletii* (红脚牛肝菌)、*B. prolinus* 和 *B. subvelutipes* (褐绒柄牛肝菌) 的区别也进行了讨论。

INTRODUCTION

Boletus Fr. 1821 is the largest genus in the *Boletales* in the broad sense, having about 300 species (Kirk et al. 2001, who include *Xerocomus* Quél.

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1887). In its strict sense, *Boletus* contains at least 130 species (Hawksworth et al. 1995). The species of this genus are widespread, but mainly distributed in North America (Singer 1947, Smith & Thiers 1971, Both 1993, Bessette et al. 2000), and Southeast and East Asia (Corner 1972, Zang 1999). In China, the most abundant distribution areas for *Boletus* are in the South and Southwest (Bi et al. 1994, Zang 1999). Chiu (1948) studied the boletes of Yunnan Province and described 20 new taxa. Since the 1980's, Chinese mycologists have carried out a series of studies on *Boletus* in Yunnan and Guangdong Provinces. Sixteen new species and twelve new Chinese records were reported (Bi et al. 1982, 1984, Zang 1983, 1991, Zang et al. 1991, Zang et al. 1993, Zang & Chen 1998, Zang et al. 1999, Zang et al. 2001, Zang & Huang 2002). So far, more than 112 species of the genus *Boletus* have been reported from China (Zang 1999, Li & Song 2000). Although many collections were identified incorrectly as European species, the Chinese bolete mycota, including *Boletus*, is actually similar to that of Malaysia, Japan, North America and even Australia (Corner 1972). Wang & Liu (2002) revised some identifications of Chinese boletes, but much more work is required to understand more thoroughly the Chinese bolete mycota.

During an investigation on the diversity of macrofungi in Gansu Province of China, a collection representing an undescribed *Boletus* was found in Zhouqu County. The county lies in the south of the province with a varied geographical and climatic environment, providing favourable conditions for *Boletus*, but mycologists have seldom been there. Based on the collection, a new species is proposed and illustrated in this paper. The colour description is based on the colour chart of Kornerup and Wanscher (1978).

TAXONOMY

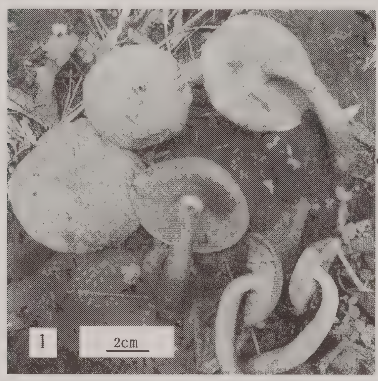
Boletus gansunensis Q. B. Wang, T. H. Li & Y. J. Yao **sp. nov.** Figs 1, 2.

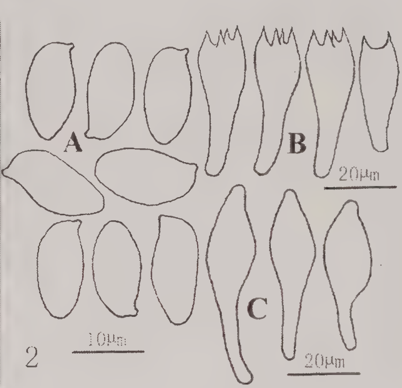
Etym.: *gansunensis*, Gansu; referring to the province in China where the new species was found.

Pileus hemisphericus vel convexus, 6–8 cm latus, rubellus, corallinus, roseus vel purpureo-rubens, vetero frequenter dilutior vel olivaceo- griseo-rubellus centro, tactu caerulescens, subviscidus, glaber vel subtomentosus. *Contextus* 1–2 cm crassus ad stipem, albus vel alboluteolus, tactu confestim viride caerulescens deinde subcaeruleus aliquando partim rubicundulus; odor et sapor indistinctus. *Tubuli* ad 8–12 mm longi, depressi ad stipitem, flavidi, flavi vel lutei, caerulescens; pori subangulares vel angulares, 1–2 per mm, salmonei vel corallinus, saepe flavidi ad stipitem et lutei margine, tactu viride caerulescens. *Stipes* cylingdricus, 7–12 cm longus, 0.6–1.2 cm crassus apice, subaequalis vel saepe leniter amplificatus deorsum, furfuraceus, roseus, purpureo-rubens vel atropurpureo-rubens, aliquando partim dilute atroviridulus, saepe striatus, apice pallide flavus, luteus vel aurantiacus, haud vel breviter reticulatus, base purpureo-rubens mycelio flavido vel albo-sulphurello, solidus. *Basidiosporae* 12.0–15.5×6.0–7.0 µm, plerumque 13.5–14.5×6.0–7.0 µm, ellipsoideae, laeves, melleae. *Basidia* 33–48×13.0–16.0 µm, clavata. *Cystidia* 40–59×10.0–14.0 µm, clavata vel fusoidea, hyalina. *Trama hymenophori* divergens. *Pileipellis* ixotrichodermio cum hyphis rubicundulis. *Hyphae* afibulatis.

Pileus hemispherical to convex, 6–8 cm broad, pale red (9A3 to 10A3) to pastel red (9A4 to 10A4), often paler or discolouring to greyish red (10B3, 10C4) and with olivaceous tint at centre when mature, becoming pale blue (23A3 to 23A4) or pale turquoise (24A3 to 24A4) where bruised, slightly viscid when moist, smooth, glabrous to subtomentous. *Flesh* 1–2 cm thick at stipe, white to yellowish white, immediately becoming blue (23A6), deep blue (23E8), greyish blue (23E7) to dark blue (23F6 or 22F6) when exposed, then slowly fading to light blue (22A4, 23A3, 23A4), partially light turquoise (24A3, 24A4) or with a little pinkish tint where the blue colour faded out, odour and taste mild. *Tubes* up to 12 mm deep, depressed around the stipe, sinuate or nearly free from stipe, pale yellow (1A3, 3A3) to yellow or orange yellow (4A5, 4A6), sometimes concolorous with pore-surface near the pore edges but usually with less red tint; pores subangular to angular, 1–2 per mm, salmon, pink, pale red or pastel red (6A4, 7A3, 7A4, 8A3 or 8A4), and with an obvious pale yellow (4A3) to orange yellow zone (4A5) at pileus margin; both pores and tubes instantly becoming dark blue (22E4, 22F4) where injured, then discolouring to pale blue (22A3 to 22A4). *Stipe* cylindrical, 7–12 cm long and 0.6–1.2 cm thick at apex, nearly equal but often slightly enlarged downwards, slightly furfuraceous, purplish red (13A6, 13B6) to dark purplish red (i.e. greyish Magenta to dark Magenta, 13D4, 13E4, 13 F4) in most portions, with a dark greenish grey tint in some specimens, often streaked with deeper or paler purplish red and greenish yellow stripes, pale yellow to orange yellow (4A3 to 4A5) at apex, purplish red near base, with yellowish or sulphurish white (1A2 or 30A2) mycelium at base, without or with a short and fine reticulum at apex, solid; colour and discolouration of stipe flesh when exposed as the flesh of pileus, or more yellow in upper and central portion, but purplish red and hardly discolouring at basal portion. *Basidiospores* 12.0–15.5×6.0–7.0 µm, mostly 13.5–14.5×6.0–7.0 µm, ellipsoid, smooth, melleous. *Basidia* 33–48×13.0–16.0 µm, clavate, 2- to 4-spored. *Cystidia* clavate to fusoid, inflated at centre, 40–59×10.0–14.0 µm, thin walled, hyaline. *Hymenophoral trama* divergent from a central strand, *Boletus*-type; hyphae brownish in KOH, thin-walled. *Pileipellis* an ixotrichodermium, reddish to nearly colourless in KOH. *Stipitipellis* a trichodermium of 42–62 µm thick, reddish brown, with palisade elements and some gelatinous materials. *Clamp connections* absent.

Specimen examined: China, Gansu Province, Zhouqu County, 2750 m alt., solitary to scattered on soil near *Betula utilis* in forest, 9 July 2002, Z. Wang & Q. B. Wang No.30 (HMAS 76819, HOLOTYPE).





Figs 1 & 2. *Boletus gansunensis* (HMAS 76819. holotype). Fig. 1. Photograph of basidiomes. Fig. 2. Line drawing of microscopic characters. A. Basidiospores: B. Basidia: C. Pleurocystida.

DISCUSSION

The new species has minute, salmon, pink, pale red or pastel red pores and a slightly furfuraceous stipe. According to Singer's system (1947), it should be classified in Section *Luridi* Fr. 1838 within *Boletus*. In the section, there are about 45 species (Singer, 1986). *Boletus gansunensis* can be distinguished from the other species within this section by its reddish to red hymenophore with an obvious yellow zone near the pileus margin, and slightly furfuraceous, purplish red to dark purplish red stipe with purplish red flesh only at the base. Some closely related species may be further compared as follows:

Boletus gansunensis is closest to *B. queletii* Schulzer 1885, which occurs in Europe. The pores of both species have an orange or yellow zone near pileus margin and the flesh in the lower part of stipe is red. According to Schulzer (1885) and Watling (1970), the European species has orange rust-coloured pores and rich lemon-yellow pileus flesh, compared with salmon, pink, pale red or pastel red pores and white to yellowish white pileus flesh in the new species. The almost cylindrical and purplish red to dark purplish red stipe also distinguishes *B. gansunensis* from *B. queletii* whose stipe often tapers to a point at the base and often has minute red dots on a yellow background in the upper part. Further, the red coloured flesh is confined to the base of stipe in *B. gansunensis*, but occupies a large proportion of the stipe in *B. queletii*. The basidiomes of *B. gansunensis* are smaller than those of *B. queletii*, which were recorded as having pileus 8.5–13 cm broad and stipe 1.1–2.2 cm thick by Schulzer (1885) and pileus 5.7–21 cm broad and 1.5–4.5 cm thick by Watling (1970).

Among the Asian species, *B. gansunensis* is close to *B. magnificus* W. F. Chiu 1948, which has a red pileus and orange red pores. The latter, however, usually grows under *Pinus armandii,* but not broad-leaved trees. Other characters, such as usually darker purple pileus; obviously red furfuraceous or dotted stipe; smaller basidiospores (9–13×4–6 µm, mostly 11×4.5 µm, Chiu 1948) and pore-surface lacking an obvious yellow zone near the pileus margin, are all different from that of *B. gansunensis*.

The new species is also reminiscent of an American species, *B. subvelutipes* Peck 1889, which has a furfuraceous stipe, with or hardly with a fine reticulum at apex. However, the American species has longer and narrower basidiospores, 13–18×4–6 (–8) µm, mostly 13–15×4.5–5.5 µm, larger basidiomes with pileus 5–18 cm broad and longer tubes up to 35 mm long (Snell & Dick 1970). Examination of one American collection (Ottawa National Forest, Imperial Lake, around Watersmeet, 23 July 1994, D. L. Richter DR94-004, Herbarium of the University of Michigan, No. 00039000) by the present authors showed the spores are 13–20 (–23) ×4 –7 (–8) µm. The American species has been found in coniferous, broad-leaf and mixed forests. According to Singer (1947), Smith & Thiers (1971), Grund & Harrison (1976) and Bessette et al. (2000), *B. subvelutipe* possesses a brown or reddish brown pileus, bright yellow pileus flesh, and a stipe covered by furfuraceous to punctate ornamentation and by dark red hairs at the base. Although the pileus flesh was whitish in Peck's original description of *B. subvelutipes* (Peck 1889), it was recorded as yellow when fresh by successive mycologists. A possible explanation for this confusion is that its context is yellow initially and stains blue instantly, then slowly fades to white (Bessette et al. 2000).

There are two Australian species, *B. barragensis* Grgur. 1997 and *B. prolinus* Grgur. 1997, which may be placed in the same section in *Boletus* with the new species described here. However, *B. barragensis* has much larger basidiospores from 14.6–20.4 µm long, and a dark, madder brown pileus. *Boletus prolinus* also has similarly large basidiospores up to 20.6 µm long and the cap is dark brown with a vinaceous tinge. The small basidiospores (12.0–15.5×6.0–7.0 µm) and red pileus with an olivaceous tint at the centre in *B. gansunensis* distinguish this Chinese species from the two Australian boletes.

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REFERENCES

Bessette, A. E., Roody, W. C. & Bessette, A. R. (2000). *North American Boletes, a Color Guide to the Fleshy Pored Mushrooms*. Syracuse: Syracuse University Press. 1–396 pp.

Bi, Z.-S., Li, T.-H., Zheng, G.-Y. & Li, C. (1984). Basidiomycetes from Dinghu Mountain of China. III. Some species of Boletaceae (2). *Acta Mycologica Sinica* **3**: 199–206. (in Chinese).

Bi, Z.-S., Lu, D.-J. & Zheng, G.-Y. (1982). Basidiomycetes from Dinghu Mountain of China. II. Some new species of Boletaceae (1). *Acta Botanica Yunnanica* **4**: 55–64. (in Chines).

Bi, Z.-S., Zheng, G.-Y. & Li, T.-H. (1994). *The Macrofungus Flora of Guangdong*. Guanzhou: Guangdong Science and Technology Press. 1–879 pp. (in Chinese).

Both, E. E. (1993). *The Boletes of North American – A Compendium*. Buffalo: Buffalo Museum of Sciences. 1–433 pp.

Chiu, W. F. (1948). The boletes of Yunnan. *Mycologia* **40**: 199–231.

Corner, E. J. F. (1972). *Boletus in Malaysia*. Singapore: Government Printer. 1–263 pp.

Grgurinovic, C. A. 1997. *Larger Fungi of South Australia*. Adelaide, South Australia: Botanic Gardens of Adelaide and State Herbarium & Flora and Fauna of South Australia Handbooks Committee. 1–725 pp.

Grund, D. W. & Harrison, K. A. (1976). *Nova Scotian Boletes*. Vaduz: J. Cramer. 1–283 pp.

Hawksworth, D. L., Kirk, P. M., Sutton, B. C. & Pegler, D. N. (1995). *Ainsworth & Bisby's Dictionary of the Fungi*. 8th Edition. Wallingford: CABI International. 1–616 pp.

Kirk, P. M., Cannon, P. F., David, J. C., & Stalpers, J. A. (2001). *Ainsworth & Bisbys's Dictionary of the Fungi*. 9th Edition. Wallingford: CABI International. 1–655 pp.

Kornerup, A. & Wanscher, J. H. (1978). *Methuen Handbook of Colour*. 3rd ed. London: Eyre Methuen. 1–252 pp.

Li, T.-H. & Song, B. (2000). Chinese boletes: a comparison of boreal and tropical elements. In Walley A. J. S. *Tropical Mycology 2000, the Millenium Meeting on Tropical Mycology (Main Meeting 2000)*. 1–9 pp. Liverpool: British Mycological Society & Liverpool John Moores University.

Peck, C. H. (1889). The boleti of the United States. *Bulletin of the New York State Museum* **2** (8): 73–166.

Schulzer, S. (1885). Einige neue pilz-species u. varietaten aus Slavonien. *Hedwigia* **24**: 143.

Singer, R. (1947). The Boletineae of Florida with notes on extralimital species. III. *The American Midland Naturalist*. **37**: 1–125.

Singer, R. (1986). T*he Agaricales in Modern Taxonomy*. 4th ed. Koenigstein: Koeltz Scientific Books. 1–981 pp.

Smith, A. H. & Thiers, H. D. (1971). *The Boletes of Michigan*. Ann Arbor: The University of Michigan Press. 1–428 pp.

Snell W. H. & Dick, E. A. (1970). *The Boleti of Northeastern North America*. Lehre: J. Cramer. 1–115pp.

Wang, X.-H. & Liu, P.-G. (2002). Notes on several boleti from Yunnan, China. *Mycotaxon*. **84**: 125–134.

Watling, R. (1970). *British Fungus Flora – Agarics and Boleti. I. Boletaceae, Gomphidiaceae, Paxillaceae*. Edinburgh: Her Majesty's Stationery Office. 1–125 pp.

Zang, M. (1983). A tentative subdivision and two new species of *Boletus* from Yunnan, China. *Acta Mycologica Sinica* **2**: 12–17. (in Chinese).

Zang, M. (1991). *Boletus brevitubus* – a new taxon of genus *Boletus* from Yunnan. *Acta Mycologica Sinica*. **10**: 11–119. (in Chinese).

Zang, M. (1999). An annotated check-list of the genus *Boletus* and its sections from China. *Fungal Science* **14**: 79–87.

Zang, M. & Chen, C.-M. (1998). Four new taxa of Basidiomycota from Taiwan. *Fungal Science* **13**: 23–28.

Zang, M. Chen, C.-M. & Sittigul C. (1999). Some new and interesting taxa of Boletales from tropical Asia. *Fungal Science***14**: 19–25.

Zang, M., Hu, M.-R. & Liu, W.-E. (1991). Two new taxa of Boletaceae from Fujian. *Acta Botanica Yunnanica* **13**: 140–152. (in Chinese).

Zang, M. & Huang, N.-L. (2002). A new species of the genus *Boletus* from China, *Boletus mininus*. *Acta Botaninca Yunnanica* **24**: 723–724.

Zang, M., Li, T.-H. & Petersen, R. H. (2001). Five new species of Boletaceae from China. *Mycotaxon* **80**: 481–487.

Zang, M., Yuan, M.-S. & Gong, M.-Q. (1993). Notes on and additions to Chinese members of the Boletales. *Acta Mycologica Sinica* **12**: 275–282. (in Chinese).

MYCOTAXON

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TYPE STUDIES ON CLITOCYBE MACROSPORA AND XERULA FURFURACEA VAR. BISPORA[1]

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Abstract The types of *Clitocybe macrospora* and *Xerula furfuracea* var. *bispora* were critically restudied. Both of them are members of *Oudemansiella*. Thus, a new name, viz. *O. bii,* and a new combination, i.e. *O. bispora* are proposed for them respectively. Important characters observed from the types were illustrated in line drawings.

Key words Agaricales, taxonomy, Asia

During study of specimens of the genus *Oudemansiella* s. l. made from China, the types of *Clitocybe macrospora* G. Y. Zheng & Loh, and *Xerula furfuracea* var. *bispora* Natarajan & K. B. Purush. were critically reexamined. The results are reported herein.

In the following account, macroscopic descriptions are based on dried specimens and field notes accompanied if any. For microscopic studies, free-hand sections of dried basidiocarps were prepared. As mounting medium, 5% KOH was used. Spores were examined in Melzer's reagent or in 5% KOH. The following abbreviation: [*n/m/p*] shall mean *n* spores from *m* basidiocarps of *p* collections. Dimensions for spores are given using notation of the form *(a–)b–c(–d)*. The range *b–c* contains a minimum of 90% of the measured values. Extreme values, e.g., *a* or *d* are given in parentheses. Q is used to mean 'length/width ratio' of a spore in side view; **Q** means average Q of all spores measured ± sample standard deviation.

1. *Clitocybe macrospora* G. Y. Zheng & Loh in C. S. Bi *et al*., Microbiol. Journ. 1: 28, Fig. 5/1–5, 1985

Basidiocarp (Fig. 1) small to medium-sized. Pileus 6.3 cm in diam.,

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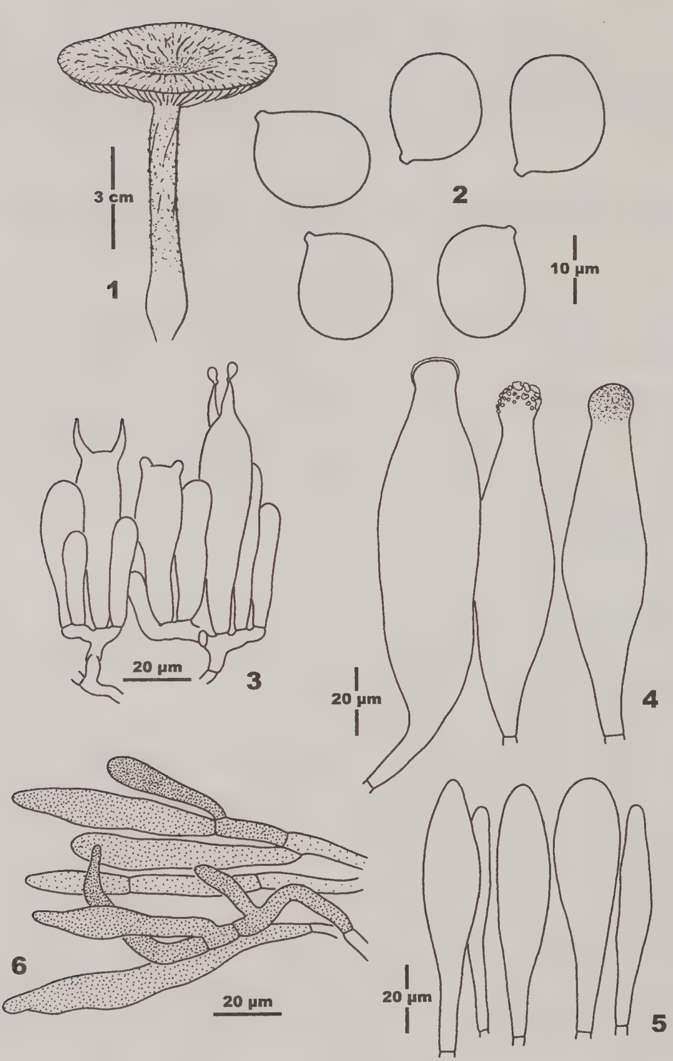

3 cm
1
2
10 µm
20 µm
3
20 µm
4
6
20 µm
20 µm
5

Figs. 1–6: *Clitocybe macrospora* (type).
1. Basidiocarp; 2. Basidiospores; 3. Basidia;
4. Pleurocystidia; 5. Cheilocystidia; 6. Caulocystidia

slightly depressed at centre, greyish with yellowish tinge, darker at disc, finely and radially rugose, slightly viscid, margin often with radially arranged translucent striations. Context of pileus white, unchanging, 2.5 mm thick at disc; taste none, odour mild. Lamellae adnate with slightly decurrent teeth, white, subdistant, with lamellulae. Stipe 6 × 0.6–0.8 cm, cylindrical to subcylindrical, downwards somewhat enlarged, fistulate, surface white to whitish, covered with brownish to brown, furfuraceous scales; annulus lacking; pseudorrhiza present, small, tapering.

Basidiospores (Fig. 2) [25/1/1] (14.5)15.0–17.0(20.0) × 12.5–14.5 (15.5) µm [Q = (1.11)1.14–1.31, **Q** = 1.20 ± 0.06], broadly ellipsoid, occasionally subglobose or ellipsoid, colourless, hyaline, inamyloid, thin- to slightly thick-walled (up to 0.5 µm thick). Basidia (Fig. 3) 40–50 × 12–18 µm, clavate, 2-spored, thin-walled, sometimes thick-walled; sterigmata 7–10 µm long; basal clamp connections usually lacking, rarely present. Pleurocystidia (Fig. 4) scattered, 90–150 × 16–35 µm, most fusiform to subfusiform, and capitate to subcapitate, occasionally broadly clavate to clavate, and then not capitate, colourless, hyaline, but apical part often with yellowish contents, thin to slightly thick-walled, often with yellowish to brownish crystalline deposits on the apex (soluble in KOH). Cheilocystidia (Fig. 5) numerous, 45–80 × (6)10–20 µm, fusiform, narrowly clavate or lanceolate, colourless, hyaline, thin-walled, forming a sterile edge along the margin of lamellae. Pileipellis hymeniform, composed of clavate to broadly clavate, sometimes sphaeropedunculate, thin-walled cells (22–40 × 7–15 µm) often with vacuolar brown to yellowish brown pigment, overlaid by a thin layer of mucilage. Pileocystidia rare to scattered, 70–100 × 10–13 µm, lanceolate to subcylindrical, thin-walled, hyaline, sometimes with vacuolar brownish pigment, apex rounded. Caulocystidia (Fig. 6) fascicular, (20)50–100 × 6–12 µm, subcylindrical to fusiform or narrowly clavate, thin- to slightly thick-walled, with vacuolar brown to yellowish brown pigment. Clamp connections rare.

Specimen examined: CHINA: Guangdong Prov.: Zhaoqing, Mt. Dinghu, 8. IX. 1980, C. S. Bi (Z. S. Bi) *et al.* 750 (GDGM 4750, type).

Remarks: The type of *C. macrospora* consists of only one basidiocarp. Because the type is in poor condition, some structures, such as the pileipellis, couldn't be illustrated. *Clitocybe macrospora* was regarded as a synonym of *Cantharocybe gruberi* (A. H. Sm.) H. E. Bigelow & A. H. Sm. by Bi *et al.* (1994). In fact, they are completely different from each other (for detailed description of *C. gruberi* see Bigelow & Smith, 1973). Due to the hymeniform pileipellis, large basidia, prominent pleurocystidia, and voluminous inamyloid smooth spores, *C. macrospora* should be placed in *Oudemansiella* s. str. according to our studies (Yang

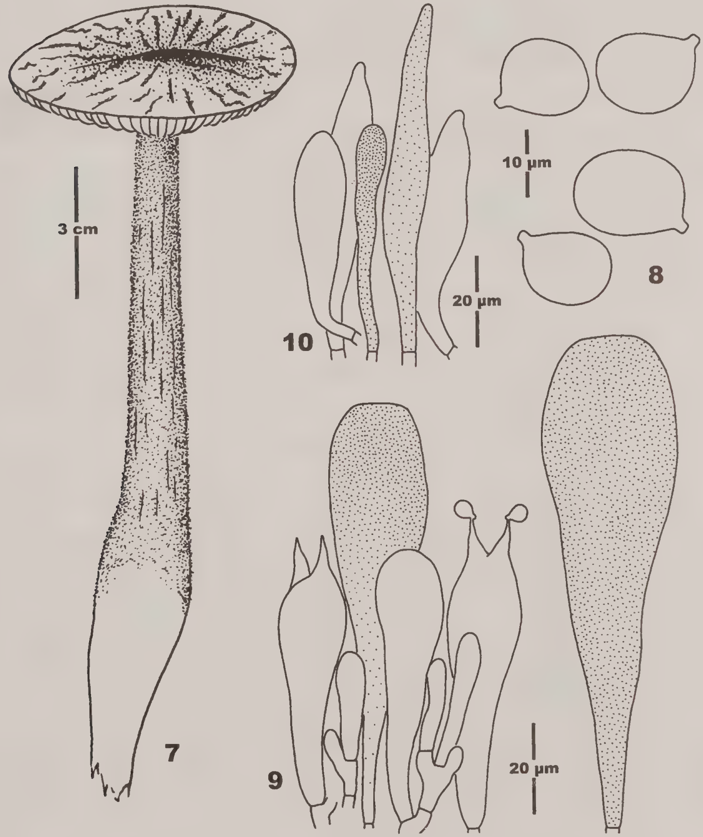
& Zang, 1993; Yang, 2000; Zhang's unpublished data). Since *O. macrospora* (Stevenson) Horak (Horak, 1971) has already been present, ***Oudemansiella bii*** Zhu L. Yang & Li F. Zhang (≡ *Clitocybe macrospora* G. Y. Zheng & Loh in C. S. Bi *et al*., Microbiol. Journ. 1: 28, Fig. 5/1–5, 1985) is proposed.

Two similar taxa, viz. *O. radicata* var. *bispora* (Redhead, Ginns & Shoemaker) Zhu L. Yang & M. Zang, and *X. furfuracea* var. *bispora* Natarajan & Purush., also have 2-spored basidia. However, *O. bii* differs from *O. radicata* var. *bispora* by the presence of furfuraceous scales on the stipe, by its smaller basidiospores, capitate pleurocystidia, and presence of pileocystidia (see Redhead, *et al*., 1987 under *Xerula radicata* var. *bispora*). *Oudemansiella bii* differs from *X. furfuracea* var. *bispora* by its capitate pleurocystidia, and dark coloured, furfuraceous scales on the stipe composed of much shorter caulocystidia often with vacuolar pigment (see below).

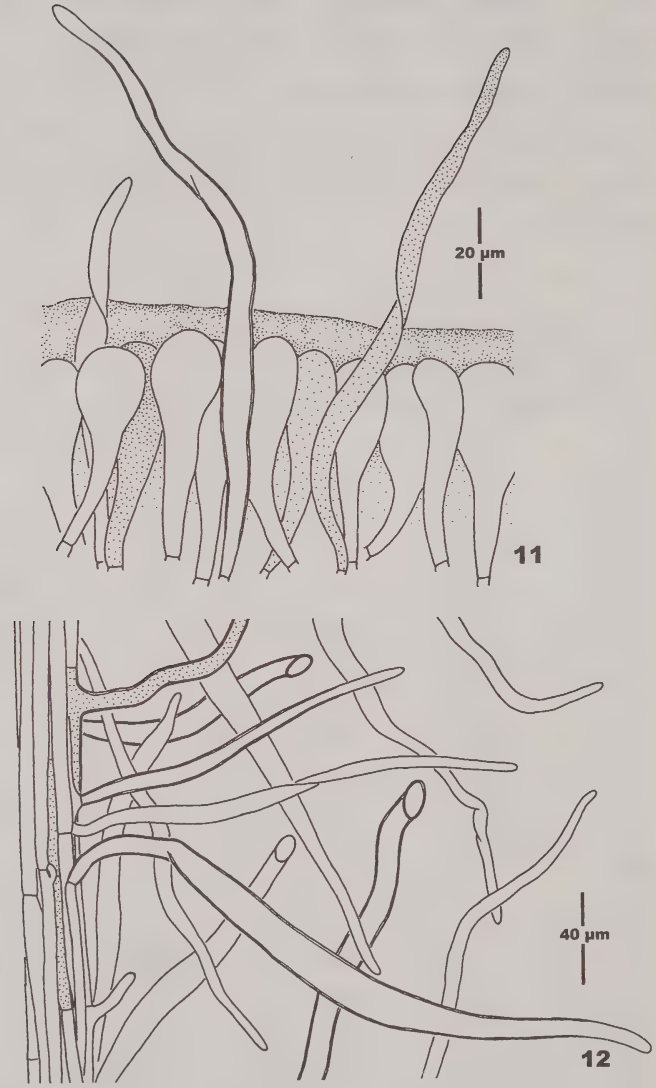
2. *Xerula furfuracea* var. *bispora* Natarajan & Purush. Intern. Journ. Mycol. Lichenol. 5 (3): 271, Fig. 1/A–H,1992

Basidiocarp (Fig. 7) medium-sized. Pileus ca. 6.5 cm in diam., convex to applanate, broadly umbonate, dark brown at disc, yellowish brown towards the margin, viscid when moist, rugose; context white, ca. 5 mm thick at disc. Lamellae adnate, white, subdistant to distant, with lamellulae. Stipe ca. 10 × 1–1.5 cm, subcylindrical, attenuate upwards, brownish to brown, finely longitudinally striate, densely covered with whitish to dirty white hairs, forming a tomentose covering over the entire exposed surface; annulus lacking; pseudorrhiza present, tapering.

Basidiospores (Fig. 8) [25/1/1] 12.0–15.0(17.0) × 10.0–13.0 µm [Q = (1.14)1.17–1.32, **Q** = 1.23 ± 0.05], broadly ellipsoid, occasionally subglobose or ellipsoid, colourless, hyaline, inamyloid, thin- to slightly thick-walled (up to 0.5 µm thick), smooth. Basidia (Fig. 9) 50–60 × 13–16 µm, clavate, 2-spored, thin-walled; sterigmata 6–9 µm long; basal clamp connections usually lacking, rarely present. Pleurocystidia (Fig. 9) scattered, 80–120 × 20–30 µm, most clavate to broadly clavate, subtruncate at apex, often with vacuolar yellow-brown pigment. Cheilocystidia (Fig. 10) numerous, 40–80 × 8–13 µm, fusiform, sometimes clavate, thin-walled, colourless and hyaline, or with vacuolar yellowish brown pigment, forming a sterile edge along the margin of lamellae. Pileipellis (Fig.11) hymeniform, composed of clavate to narrowly clavate, sometimes sphaeropedunculate, thin-walled cells (30–70 × 9–20 µm) sometimes with vacuolar yellowish brown pigment, overlaid by a thin layer of mucilage. Pileocystidia (Fig. 11) scattered to fairly abundant, 70–150 × 5–8 µm, lanceolate to subcylindrical, thin- to slightly thick-walled (<1 µm), nearly colourless and hyaline, sometimes with vacuolar brown pigment, apex rounded, cell wall yellowish. Caulocystidia (Fig. 12) numerous, covered the whole surface of stipe, 150–320 × 7–20 µm, subcylindrical to lanceolate or subfusiform, thin- to slightly thick-walled (up to 1.5 µm thick), nearly colourless and hyaline, rarely with vacuolar yellowish brown pigment, apex narrowly rounded. Clamp connections present but rare.



Figs. 7–10: *Xerula furfuracea* var. *bispora* (type).
7. Basidiocarp; 8. Basidiospores; 9. Basidia and pleurocystidia;
10. Cheilocystidia


20 µm
11
40 µm
12

Figs. 11–12: *Xerula furfuracea* var. *bispora* (type).
11. Pileipellis and pileocystidia; 12. Surface of stipe and caulocystidia.

Specimen examined: INDIA: Tamil Nadu, Nilgiris Hills, on soil in *Pinus patula* plantation, 28. VIII. 1982, K. Natarajan *s.n.* (MUBL 2922, holotype).

Remarks: We studied one basidiocarp of the holotype. Although the specimen is not in very good condition, some critical structures could still be observed, and illustrated.

Xerula furfuracea var. *bispora* differs from *Xerula furfuracea* var. *furfuracea* by its wider basidiospores, 2-spored basidia, narrower pileocystidia, smaller cheilocystidia, significantly longer caulocystidia, and the rarity of clamp connections. Furthermore, the stipe of the former is densely covered with a whitish to dirty white tomentum over the entire exposed surface, while that of the latter is usually covered with darker coloured, furfuraceous scales (Redhead *et al.*, 1987). We are inclined to treat the Indian material as a distinct species. According to our studies (Yang & Zang, 1993; Yang, 2000; Zhang's unpublished data), the taxa around *Xerula furfuracea* should be put in the genus *Oudemansiella* s. str. Thus, a new combination with species rank, ***Oudemansiella bispora*** (Natarajan & Purush.) Zhu L. Yang & Li F. Zhang comb. nov. & stat. nov. [≡ *Xerula furfuracea* var. *bispora* Natarajan & Purush. Intern. Journ. Mycol. Lichenol. 5 (3): 271, Fig. 1/A–H,1992] is proposed.

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We are very grateful to Dr. T. H. Li, Guangdong Institute of Microbiology (DGGM), China for allowing us access to the specimens there, and to Dr. K. Natarajan, University of Madras (MUBL), India for sending us the holotype of *Xerula furfuracea* var. *bispora* on loan. We express our sincere gratitude to Dr. T. J. Baroni, State University of New York, College at Cortland, New York, USA for reviewing this paper.

References

Bi C. S. (Bi Z. S.), Zheng G. Y., Loh T. C., Li C. & Li T. H. (1985): Some new species and varieties of Agaricales from Dinghu Mountain. Micribiol Journ 1 (1): 24–30.

Bi Z. S., Zheng G. Y. & Li T. H. (1994): "Macrofungus Flora of Guangdong Province". Guangzhou: Guangdong Science and Technology Press.

Bigelow H. E. & Smith A. H. (1973): *Cantharocybe*, a new genus of Agaricales.

Mycologia 65: 485–486.

Horak E. (1971): A contribution towards the revision of the Agaricales (Fungi) of New Zealand. New Zealand J. Bot. 9: 403–462.

Natarajan K. & Purushothama K. B. (1992): A new variety of *Xerula furfuracea* from India. Intern. Journ. Mycol. Lichenol. 5: 271–271.

Redhead S. A., Ginns J. & Shoemaker R. A. (1987): The *Xerula* (*Collybia, Oudemansiella*) *radicata* complex in Canada. Mycotaxon 30: 357–405.

Yang Z. L. & Zang M. (1993): “Classification of the genus *Oudemansiella* Speg. in Southwest China”. Acta Mycol. Sinica 12: 16–27.

Yang Z. L. (2000): Further notes on the genus *Oudemansiella* from southwestern China. Mycotaxon 74: 357–366.

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AMANITA YENII, A NEW SPECIES OF AMANITA SECTION LEPIDELLA*

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Abstract: A new species, *Amanita yenii*, of the genus *Amanita* sect. *Lepidella* is described and illustrated based on collections made from Taiwan Island and mainland China.

Key words: taxonomy, Amanitaceae, new taxon

An undescribed species of *Amanita* section *Lepidella* is common in tropical and subtropical regions of mainland China and Taiwan. It is described and illustrated herein. Methodology and notation follow those of Yang (1997) and Yang, Weiß & Oberwinkler (2003). Color names with first letters capitalized are from Ridgway (1912); color codes of the form "1A1–2" are from Kornerup & Wanscher (1981). Herbarium codes used follow Holmgren, Holmgren & Barnett (1990) with one exception: HKAS = Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences, which is not listed in the index.

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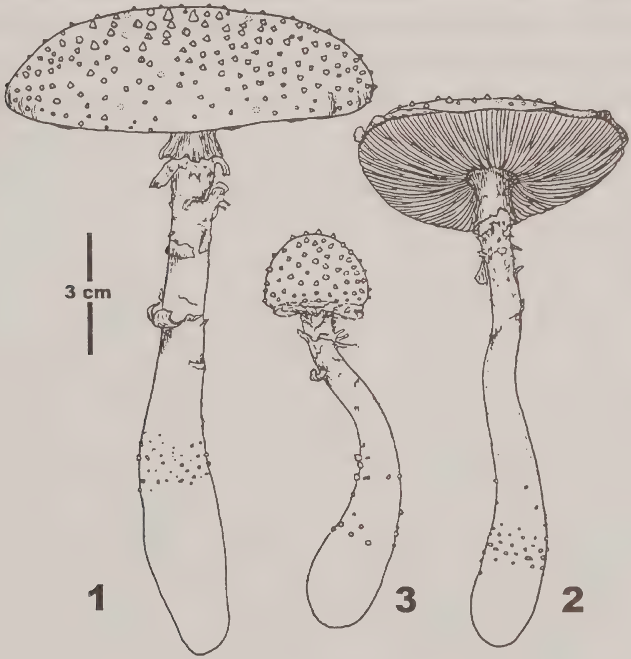
Amanita yenii Zhu L. Yang & C. M. Chen, **sp. nov.**

Pileus 5–10 cm latus, convexus vel applanatus, albus vel albidius, saepe disco cremeo; margine non striata, appendiculata; reliquiis volvae coactis, conicis vel subconicis, albis vel albidiis, interdum brunneolis ornatus. Lamellae liberae vel subliberae, cremeae vel subflavidae, confertae, lamellulis attenuatis. Stipes 6–12 × 0.5–1.5 cm, subcylindricus vel sursum attenuatus, albus, annulatus, bulbo clavato vel subclavato vel ventricoso, non marginato, 1.5–3 cm lato, reliquis volvae albidiis, verrucosis vel subconicis. Annulus cremeus vel subflavidus, superior, fragilis. Caro alba. Basidia 30–50 × 7–10 µm, 4-sporigera. Sporae (6.5) 7.5–10.0 (12.5) × (4.0) 4.5–6.5 (7.5) µm, ellipsoideae vel elongateae, amyloideae. Fibulae absentes. Holotypus: C.M. Chen 3284 (HKAS 41328), 5. VI. 2002, Riyuetan, Nantou, Taiwan, China.

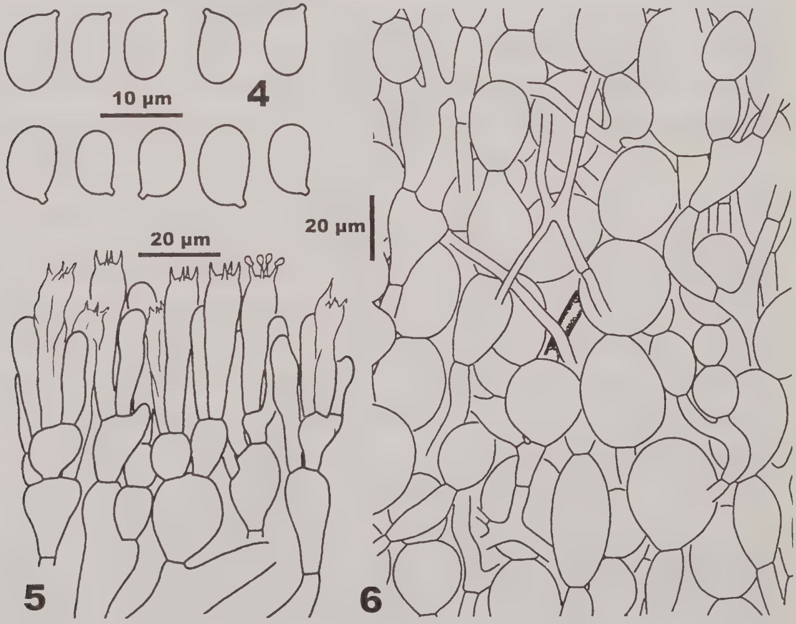
Etymology: named in honour of Mr. Jen-Teh Yen, former director of Taiwan Endemic Species Research Institute, whose efforts played a major role in establishing the institute for research and conservation on biodiversity and natural resources in Taiwan.

Basidiocarps medium-sized to large (figs. 1–3). **Pileus** 5–10 (12) cm in diameter, convex to applanate, white [1A1] to whitish or dirty white, but cream-colored or pale yellowish [Cream Color, Pale Chalcedony Yellow, 2A2, 3A2] over disc when young; volval remnants conical to subconical, 1–3 (4) mm high, 1–3 (4) mm wide, white [1A1] to dirty white, occasionally brownish, especially towards apex, randomly arranged; margin smooth, appendiculate. **Lamellae** subfree to free, white when young, becoming cream-colored to yellowish [Cream Color, Pale Chalcedony Yellow, 2A2] when mature, crowded; lamellulae attenuate, evenly distributed. **Stipe** 6–12 × 0.5–1.5 cm, subcylindrical or tapering upwards, with apex slightly expanded, white [1A1], upper half often covered with white, recurving squamules, lower half glabrous or fibrillose; basal bulb clavate to subclavate or ventricose, 1–3 cm wide, non-marginate, with upper part nearly completely glabrous (volval remnants left in soil) or covered with whitish to white, occasionally brownish, verrucose to subconical volval remnants, irregularly arranged or in incomplete concentric rings. **Annulus** pendant from attachment 0.5–1.5 (2) cm below apex of stipe, with upper surface cream-colored to yellowish (Cream Color, 2A2–3), with lower surface white, thin, submembranous. **Trama** white, unchanging. **Smell** and **taste** indistinct.



Figs. 1–3. Basidiocarps of *Amanita yenii*
1–2. HKAS 41328-holotype; 3. HKAS 38800. After photos

Lamellar trama bilateral. **Mediostratum** 30–50 µm wide, composed of fairly abundant to abundant subfusiform to long ellipsoid, inflated cells (55–120 × 13–25 µm), mixed with abundant, filamentous hyphae 2–7 µm wide; vascular hyphae rare, 2–8 µm wide. **Lateral stratum** composed of fairly abundant to abundant long ellipsoid to clavate, inflated cells (40–90 × 10–25 µm), mixed with abundant filamentous hyphae 3–7 µm wide, diverging at an angel of ca. 45° to the mediostratum. **Subhymenium** (fig. 5) 20–40 (50) µm thick, with (1) 2–3 layers of subglobose to ovoid (10–23 × 8–18 µm) or ellipsoid to irregularly shaped (15–30 × 10–15 µm) inflated cells. **Basidia** (fig. 5) 30–50 (57) × 7–10 µm, clavate, 4-spored, occasionally 2-spored; sterigmata 3–4 (5) µm long; basal septa without clamps. **Basidiospores** (fig. 4) [322/13/12] (6.5) 7.5–10.0 (12.5) × (4.0) 4.5–6.5 (7.5) µm [Q = (1.23) 1.33–1.80 (2.11), **Q** = 1.55 ± 0.15], ellipsoid to elongate, rarely broadly ellipsoid or cylindrical, amyloid, colorless, hyaline, thin-walled, smooth; apiculus small. **Lamellar edge** as sterile, incomplete strip up to 250 µm wide in side view, composed dominantly of subglobose to ovoid or broadly ellipsoid,



Figs. 4–6: *Amanita yenii* (holotype)
4. Basidiospores; 5. Hymenium and subhymenium;
6. Longitudinal section of a volval remnant on pileus

inflated cells (8–25 × 8–20 µm), single and terminal, or in chains of 2–3 (5) and then terminal, thin-walled, colorless, hyaline; filamentous hyphae 3–5 µm, scattered, irregularly arranged. **Pileipellis** hardly differentiated, composed of subradially arranged, filamentous hyphae up to 2–8 (12) µm wide, rarely gelatinized, colorless, hyaline, thin-walled to slightly thick-walled (up to 0.5 µm thick), surface of hyphae sometimes with refractive granular substances; vascular hyphae rare to locally conspicuous, 2–10 µm wide. **Volval remnants** (fig. 6) on pileus composed of ± vertically, at volval base irregularly, arranged elements. Inflated cells very abundant to dominant, subglobose to ovoid (10–60 × 10–50 µm), sometimes ellipsoid (25–60 × 15–30 µm), often in chains of 2–4 and terminal, thin-walled to slightly thick-walled (up to 0.5 µm thick), colorless, hyaline; filamentous hyphae scattered to fairly abundant, somewhat more abundant in volval remnant base than elsewhere, 2–7 (12) µm wide, frequently branching and anastomosing, interwoven, thin-walled, colorless, hyaline; vascular hyphae rare, 2–10 µm wide. Volval remnants on upper part of basal bulb similar to those on pileus, but with filamentous hyphae somewhat more abundant and inflated cells often in shorter chains. **Stipe trama** composed of abundant, longitudinally arranged, long clavate, terminal cells 250–300 × 15–30 µm, mixed with fairly abundant to abundant filamentous hyphae 2–8 µm wide; vascular hyphae locally conspicuous, 1.5–12 µm wide. **Annulus** composed of abundant to very abundant, clavate to broadly clavate or subglobose (17–40 × 15–30 µm) or ellipsoid (70–90 × 12–25 µm), colorless, hyaline, thin-walled, inflated cells; filamentous hyphae fairly abundant, loosely arranged, 2–7 µm wide, thin-walled, colorless, hyaline; vascular hyphae rare; upper surface of annulus gelatinised. Clamps not found.

Specimens examined: CHINA. Hainan: Changjiang County, Bawang- ling, 21-VIII-1990, Q. Chen s.n. (GDGM 16681); Ledong

County, Jianfengling, alt. 700 m, 5-V-1960, J.H. Yu & R. Liu 1277 (HMAS 29133); same location, alt. 900 m, 18-VIII-1999, M.S. Yuan 4318 (HKAS 34567); same location, alt. 900 m, 2-IX-1999, X.L. Wu 7 (HKAS 34097); same location, alt. 870 m, 3-IX-1999, X.L. Wu 9 (HKAS 34099). Taiwan: Nantou County, Huisun Forest Station, 10-VIII-2000, C.M. Chen 2474 (HKAS 37137); same location, 24-V-2001, C.M. Chen 2818 (HKAS 38800); Nantou County, Riyuetan, 12-VII-2000, C.M. Chen 2414 (HKAS 37136); same location, 800 m, 5-VI-2002, C.M. Chen 3284 (HKAS 41328, HOLOTYPE); same location, 24-VI-2002, C.M. Chen 3329 (HKAS 41326); same location, 4-IX-2002, C.M. Chen 3570 (HKAS 41327). Yunnan: Jinghong County, Dadugang, alt. 600 m, 7-VIII-2001, Z.L. Yang 3165a (HKAS 41113).

Habitat and Distribution: on ground in forests.

Observations: *Amanita yenii* is a member of *Amanita* subgenus *Lepidella* (J.-E. Gilbert) Veselý emend. Corner & Bas sect. *Lepidella* (Bas 1969). It is characterized by its white fruitbody with conical to subconical, white to whitish volval remnants on the pileus, yellowish lamellae, a clavate to ventricose bulb gradually passing into the stipe, ellipsoid to elongate amyloid spores, and the absence of clamps.

Amanita yenii may be keyed out in subsect. *Solitariae* Bas stirps *Polypyramis* (1969). It is useful to compare two species of this stirps, *A. polypyramis* (Berk. & Curt.) Sacc. and *A. boudieri* Barla, with *A. yenii*. *Amanita polypyramis*, originally described from North America, usually has a more robust basidiocarp often with strong smell, smaller warts of volval remnants on the pileus, paler colored lamellae, a more or less submarginate bulb on the base of the stipe and significantly larger basidiospores (Bas 1969, Jenkins 1986, Tulloss *et al.* 1995). *Amanita boudieri* [= *A. baccata* (Fr.) Gill., See (Bas & Honrubia 1982)], originally described from Europe, has a more fugacious annulus, and much longer basidiospores. Furthermore, its volval remnants on the pileus are mostly rather adnate, subtomentose-subfelted patches or small warts, and its stipe is glabrous to subglabrous, without reflexed squamules on its upper part [see (Bas 1969)].

In eastern Asia and southeastern Asia, *A. yenii* looks like *A. virginea* Massee and *A. virgineoides* Bas, originally described from Singapore and Japan respectively. However, *A. virginea* has a more robust basidiocarp with a more fugacious annulus, white to whitish lamellae, much wider basidiospores, and common clamps. *Amanita virgineoides* has a larger and stout basidiocarp with white to cream lamellae, thicker annulus, wider basidiospores, and common clamps. In addition, the stipe of *A. virgineoides* is often covered with transversely arranged small squamules (Bas 1969, Imazeki *et al*. 1988, Yang 1997).

The volval remmants on the pileus of *A. yenii* are sometimes brownish, which calls to mind *A. hongoi* Bas and *A. perpasta* Corner & Bas (Corner & Bas 1962, Bas 1969). However, *A. hongoi* has a larger and more robust basidiocarp with more or less brownish pileus, wider basidiospores, and more vascular hyphae in the volval remnants on the pileus (Bas 1969, Yang & Doi 1999). The stipe of *A. hongoi* is often covered with transversely arranged small, whitish to brownish squamules (Yang's unpublished data). *Amanita perpasta* has signify-cantly larger and darker volval remnants on the pileus, and wider basidiospores. Its stipe is covered with brownish granules or scales (Corner & Bas 1962, Bas 1969, Hongo 1977).

GDGM 16681 was regarded as *A. solitaria* by Bi *et al*. (1997). However, the European *A. solitaria* (Bull.: Fr.) Fr. has greenish-yellowish lamellae, reflexed squamules on the base of the stipe, larger spores, and clamped basidia (Bas 1969).

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References

BAS C (1969) Morphology and subdivision of *Amanita* and a monograph of its section *Lepidella*. Persoonia 5: 285–579.

BAS C, HONRUBIA M (1982) Validation of *Amanita gracilior*, a mediterranean species resembling *A. boudieri*. Persoonia 11: 511–514.

BI ZS, LI TH, ZHANG WM, SONG B (1997) “A Preliminary Agaric Flora of Hainan Province”. Guangzhou: Guangdong Higher Education Press.

CORNER EJH, BAS C (1962) The genus *Amanita* in Singapore and Malaya. Persoonia 2: 241–304.

HOLMGREN PK, HOLMGREN NH, BARNETT LC (1990) Index Herbariorum. Part I. Herbaria of the World. 8th edn. New York: New York Botanical Garden.

HONGO T (1977) Notulae mycologicae (15). Mem. Fac. Liberal Arts Shiga Univ.，Pt. 2，Nat. Sci. 27: 20–25.

IMAZEKI R，OTANI Y，HONGO T (1988) “Fungi of Japan”. Tokyo: Yama-kei Publishers Co., Ltd.

JENKINS DT (1986) *Amanita* of North America. California: Mad River Press.

KORNERUP A, WANSCHER JH (1981) Taschenlexikon der Farben. 3. Aufl. Göttingen: Muster-Schmidt Verlag.

RIDGEWAY R (1912) Color Standards and Color Nomenclature. Washington DC: R. Ridgeway.

TULLOSS RE, STEPHENSON SL, BHATT RP, KUMAR A (1995) Studies on *Amanita* (Amanitaceae) in West Virginia and adjacent areas of the mid-Appalachians. Preliminary results. Mycotaxon 56: 243–293.

YANG ZL (1997) Die *Amanita*-Arten von Südwestchina. Bibliotheca Mycologica 170: 1–240.

YANG ZL, DOI Y (1999) A contribution to the knowledge of *Amanita* (Amanitaceae, Agaricales) in Japan. Bull. Natn. Sci. Mus., Tokyo, Ser. B., 25: 107–130.

YANG ZL, WEIß M & OBERWINKLER F (2003) New species of *Amanita* from eastern Himalayas and adjacent regions. Mycologia (to appear).

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A NEW SPECIES, PISOLITHUS ABDITUS, AN ECTOMYCORRHIZAL FUNGUS ASSOCIATED WITH DIPTEROCARPS IN THAILAND

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Keywords: *Pisolithus,* gasteromycetes

Abstract

Descriptions and illustrations are provided of a new *Pisolithus* species collected under *Dipterocarpus alatus* in Thailand: *Pisolithus abditus* nov. sp. with snuff brown clavate basidiomes, slightly curved stipes and globose to subglobose basidiospores. It is compared with similar species.

Introduction

Pisolithus is a genus of gasteromycetes with worldwide distribution that forms ectomycorrhizas with a wide range of angiosperm and gymnosperm tree species (Marx 1977).

Although considerable variation exists in physiology and morphology of basidiomes, basidiospores and isolated mycelium, taxa previously described in *Pisolithus* were commonly regarded as conspecific (Watling *et al.* 1995). However, DNA-based molecular analysis reveals the presence of clearly separate biological species within what has been described as *P. tinctorius* (Martin, Delaruelle & Ivory 1998, Cairney, Chambers & Anderson 1998, Gomes *et al.* 2000, Diez *et al.* 2001, Anderson, Chambers & Cairney 2001, Martin *et al.* 2002). Recently, Martin *et al.* (2002) confirms based on analysis of ITS sequences in nuclear ribosomal DNA that a numbers of *Pisolithus* species exist worldwide. There may be still new species to be found in some regions of world.

We are engaged in molecular phylogeny of *Pisolithus* species in Thailand in order to obtain a basic knowledge for further investigation on molecular ecology of Thai

Pisolithus, and found an interesting *Pisolithus* species under dipterocarp trees whose ITS sequence and morphology did not match any previously reported species. In this paper we therefore propose it as new species.

Pisolithus abditus nov. sp. Kanchanaprayudh, Sihan., Hogetsu & Watling (Fig.1)

Peridion erecto, fuligineo vel umbrino-brunneo, glabro, nitido, fuscente, clavate, basi angustate; peridioles bubalinum lentiformis, glabrus; sporis in cumulo fulvo-ferrugineus. Basidiosporis globosae-subglobosae, verrucosae, 8-10.5 µm diam.. Holotypus: Thailand, 22 vi 2002, legit Prakitsin Sihanonth, Wat. 28209 (E)

Basidiomes 50–85 mm. high, pedicellate to broadly clavate, divided into a distinct head and cylindric or slightly curved stipe, snuff brown to dark fuliginous brown with a black shiny surface especially around the base of the head and on upper stipe entirely smooth at first then cracking but not squarrose or scaly.

Peridium 30–35 mm. broad, broadly ellipsoid to subglobose, stipitate, smooth, thin, brittle, snuff brown to fuliginous, covered in places especially at junction of stipe and head and lower part of head with black, shiny smooth surface, finely cracking into segments and breaking up at apex to expose powdery surface. **Stipe** 30–65 x 7–16 mm., woody, snuff brown to fuliginous, smooth and shining, cylindric and expanded into a flattened thick, whitish base of agglutinated mycelium and soil, with yellowish rhizomorphs. **Gleba** a ferruginous brown powdery mass formed by the breakdown of rounded, smooth, clay-buff peridioles 1.5 mm. diam., seated in small pockets within the peridium and upper part of stipe, passing into >1mm. peridioles and solid part of the stipe; **peridioles** thin-walled, at first clay buff then more and more ferruginous as they mature, discrete but soon breaking down into a powdery fluffy mass; exuding a deep amber to orange fluid when mounted in alkali solutions. **Constituent hyphae** intertwined, narrow >3.5 µm broad, varying from hyaline to rich ochraceous, rather rigid with or without debris-like encrustations*. **Basidiospores** globose 8-10 µm diam. to subglobose 8-10 x 9-10.5 µm, including heavy ornamentation consisting of isolated groups of connate narrow cones adhering together to form blunt pegs lacking joining wings or connections, pale brown in alkali solutions and slightly darker in Melzer's solution. **Basidia**+ 2-, 3- or 4-spored, 15.5-22.5 x 8-11µm, hyaline, pedicellate with short or narrow and long foot, shortly clavate to almost globose, developing in loose clusters seated on narrow, minutely encrusted hyphae* but soon collapsed and not found. **Cystidia and cystidioid cells and clamp-connections** absent.

Habitat: Terrestrial on sandy loam – sand over granitic rock; in 7 year-old treated 1.2 acre dipterocarp plantation of *Dipterocarpus alatus* with ground cover of 'Malaysian grass'. The treatment wass chicken manure at 2.5 tons per acre. **Material examined**: Khao Hin Sorn Royal Development Study Area, Panomsarakarm District, Chacherngsoa

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* Encrustations on glebal and peridial hyphae exuding an amber-coloured liquid.

+ Rarely given in formal or florisitic descriptions because they are only seen in young ripening peridioles.

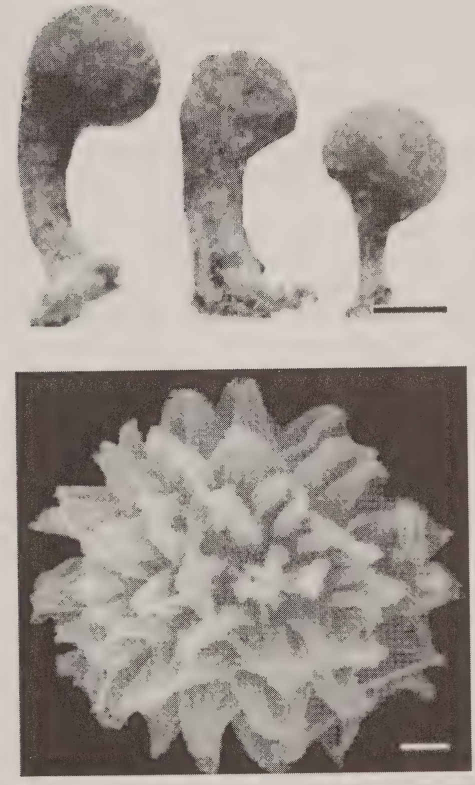

Fig. 1. *Pisolithus abditus.* Above: basidiomes, Bar = 2.0 cm. Below: scanning electron micrograph of a mature basidiospore, Bar = 1μm.

Province, Thailand, 22 vi 2002, legit Prakitsin Sihanonth, Wat 28209 in **E** (holotype). Isotype material in Chulalongkorn University Herbarium, Bangkok, Thailand.

This is the second species of *Pisolithus* to be described from dipterocarp forest, the other being *P.aurantioscabrosus* Watling from Malaysia which differs, as its name suggests, in the orange-coloured squarrose scales ornamenting the peridium. The present species comes closer to some of the collections found in national herbaria generally labelled '*P. tinctorius*', the correct name for at least some of the European collections being *P. arhizus* (Pers.) Rauschert. The other collections undoubtedly belong to other taxa which have been lumped under a single epithet. The similarity with these collections lies in the smooth, black crust to the peridium and upper stipe but generally *P. arhizus, Polysaccum album* Cooke & Massee, with its persistently white peridium and *Polysaccum marmoratum* Berk. are all larger and generally found in more open arid areas: *Polysaccum* is a synonym of *Pisolithus*. The last two species are associated with eucalypts.

It is true that some of these taxa have been introduced to countries from Australia and are now to be found outside their natural range, such as the collections recorded from eucalypt plantations in Central Africa (Dissing & Lange, 1964 as *P. tinctorius* & in a legend to Plate XLII fig. 7 *P. arenarius* Alb. & Schwein.; Watling pers. obs.: Zambia, Kitwe, Chati Forest reserve, 4.iv.1991, Wat. 2444 in **E**). However, none as yet have been recorded in native or planted dipterocarp forests.

The morphological similarities and differences are confirmed by our molecular study (Kanchanaprayudh *et al*., 2003). It indicates considerable separation of the lowland rainforest, orange-scaled Malaysian *P. aurantioscabrosus* from a major grouping divided into two strong branches, one containing 4 entities surrounding the *P. albus* and *P. microcarpus* consortia (Martin *et al.*, 2002) and associated with eucalypts and acacias and a second containing the more familiar *P. arhizus* and *P. marmoratus* consortia (7 entities), associated with a range of vascular plant hosts. It is as a subgroup from this latter branch that the new taxon described above is found. Interestingly it is linked there with an unnamed African taxon associated with *Afzelia,* a caesalpinoid legume (Martin *et al*., 2002) and of course Africa is the home also of some rather ancient ectomycorrhizal dipterocarpous genera, *e.g., Marquesia,* indicating a possible early link in these floriatic components; see Watling 1993 and 1994. *Pisolithus abditus* is in a branch of the tree with a taxon associated with either caesalpinoid legumes or dipterocarps whereas the *P. albus* complex is associated with myrtaceous trees and mimosoid legumes indicating that different dipterocarps and legumes arose as host species with different pisolithoid fungi. Scanning electron micrographs indicate that the spore ornamentation does not resemble that of *P. aurantioscabrosus* but rather the basidiospores of collections from Australian native *Eucalyptus* forest and plantations there and in other parts of the world, viz. Types A & B in Watling *et al*., 1995.

Polysaccum kisslingii E. Fisch., described from Sumatra (Indonesia), as in many of the Australian species, is also of large size and differs from the present taxon particularly in its elongate facies, viz. 20 mm. broad, yellow-brown colours and fibrous-squamose surface. *P. pusillum* Har. & Pat., from New Caledonia, comes close in size and in its blackish (to olivaceous) colours but it has a rugulose and non-shiny surface to the peridium.

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References

Anderson, I. C., Chambers, S. M. & Cairney, J. E. G. 1998. Molecular determination of genetic variation in *Pisolithus* isolates from a defined region in New South Wales, Australia. *New Phytologist* **138**: 151-162

Anderson, I. C., Chambers, S. M. &Cairney, J. E. G. 2001. ITS-RFLP and ITS sequence diversity in *Pisolithus* from central and eastern Australia sclerophyll forests. *Mycologocal Research* **105**: 304-1312.

Diez, J., Anta, B., Manjon, J. L. & Honrubia M. 2001. Genetic variability of *Pisolithus* isolates associated native hosts and exotic eucalyptus in the western Mediterranean region. *New Phytologist* **149**: 577-587.

Dissing, H. & Lange, M. (1964) Gasteromycetales II. in *Flore Iconographique des Champignons du Congo.* Fasc. **13**: 233-252.

Gomes, E. A., Abreu, L. M., Borges, A. C. & Araujo EF. 2000. ITS sequences and mitochondrial DNA polymorphism in *Pisolithus* isolates. *Mycological Research* **104**: 911-918.

Kanchanaprayudh, J., Zhou, Z., Yomyart, S., Sihanonth, S. & Hogetsu, T. (2003) Molecular phylogeny of ectomycorrhizal *Pisolithus* fungi associated with pine, dipterocarp and eucalyptus trees in Thailand. *Mycoscience* 44: 287-294.

Martin, F., Delaruelle, C. & Ivory M. 1998. Genetic variation in intergenic spacers of ribosomal DNA in *Pisolithus* isolates associated with pine, eucalyptus and *Afzelia* in lowland Kenyan forests. *New Phytologist* **139**: 341-352

Martin, F., Diez, J., Dell, B. & Delaruelle, C. (2002) Phylogeography of the ectomycorrhizal *Pisolithus* species as inferred from nuclear ribosomal DNA ITS sequences. *New Phytologist* **153**: 345-357.

Watling, R. (1994) Ectomycorrhizal fungi in the Palaeotropics. *Mycologia Helvetica* **2**: 129-138.

Watling, R. (1993) Comparison of the macromycete biotas in selected tropical areas of Africa and Australia. In *Aspects of Tropical Mycology.* pp.171-192. Eds. Isaac, S., Frankland, J.C., Watling, R. & Whalley, A.J.S., British Mycological Society, UK.

Watling, R., Taylor, A., Lee, S.S., Sims, K. & Alexander, I. (1995) A rainforest *Pisolithus*: its taxonomy and ecology. *Nova Hedwigia* **61**: 417-429.

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ANTHRACOIDEA STENOCARPAE, THE ORTHOGRAPHICALLY CORRECT NAME FOR A SPECIES DESCRIBED FROM THIAN SHAN

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The author earlier described the fungus *Anthracoidea stenocarpa* Chleb. from Thian Shan in Kazakhstan (Chlebicki 2002). Further localities for the fungus were reported by Chlebicki (2003). The epithet used for the name of the fungus was derived from the epithet of the host plant, *Carex stenocarpa* Turcz. ex V. I. Krecz. The species epithet should be spelled in accordance with spelling of the host plant name (Art. 60 of Tokyo Code, see Hawksworth 2001). Unfortunately the epithet used by the author (Chlebicki 2002) possesses an orthographic error, since Latin terminations should take the form of a substantive in the genitive (ICBN, Art. 32.6). Accordingly, the following orthographic correction is necessary:

Anthracoidea stenocarpae Chlebicki, Mycotaxon 83: 282, 2002, (ut *Anthracoidea stenocarpa*).

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LITERATURE

CHLEBICKI A. 2002. Two cypericolous smut fungi (*Ustilaginomycetes*) from the Thian Shan and their biogeographic implications. *Mycotaxon* **83**: 279–286.

CHLEBICKI A. 2003. Some *Anthracoidea* species (*Ustilaginomycetes*) from Thian Shan. *Fritschiana (Graz)* **42:** 10-13.

HAWKSWORTH D. L. 2001. The naming of Fungi. In: MCLAUGHLIN D. J., MCLAUGHLIN E. G. & LEMKE P. A. (eds.) *The Mycota* 7 part B: 171-192. Springer-Verlag, Berlin, Heidelberg.

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THE GENUS PERTUSARIA (LICHENISED ASCOMYCOTINA) ON THE IBERIAN PENINSULA AND BALEARIC ISLANDS. I SUBGENUS PERTUSARIA

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ABSTRACT: The genus *Pertusaria* is widespread in Spain and Portugal, where, to date, it includes 44 species. We have found 21 species of the subgenus *Pertusaria* in the Spanish and Portuguese florae. We propose two new species: *P. luteola* sp. nov. and *P. werneriana* sp. nov. One taxon is reduced to synonymy (*P. maximiliana* to *P. heterochroa*) and *P. dispar, P. plombii* and *P. praelutescens* are new records for Spain.

Key words: *Pertusaria luteola, Pertusaria werneriana,* lichens, taxonomy, Pertusariaceae, Mediterranean region

INTRODUCTION

In floristic papers on the Iberian Peninsula and Balearic Islands several species of the genus *Pertusaria* have been cited. According to a recent checklist (LLIMONA & HLADUN 2001), 98 species, 1 subspecies, 48 varieties and 9 forms have been reported in the area.
Erichsen revised the genus *Pertusaria* in 1936 (ERICHSEN,1936) and more recent monographs have been written for North America by DIBBEN (1980), Europe by HANKO (1983: 29 species of the genus reported from the Iberian Peninsula), and Australia by ARCHER (1997). Other papers describe the chemical and morphological characters of the genus (SCHREINER & HAFELLNER, 1992; TØNSBERG, 1992; PURVIS *et al*., 1992). Recently, ARCHER (1993, 1995) added new chemical and morphological data to the knowledge of the genus, and suggested a further division into subgenera viz: *Pertusaria, Pionospora* and *Monomurata*. However, recent phylogenetic studies (LUMBSCH & SCHMITT, 2001 and SCHMITT, 2002) have shown that subgenus *Pionospora* is not separated from subgenus *Pertusaria*. Subgenus *Monomurata* is separated and was found to be related to *Ochrolechia*.
However, no review article has been published recently on southern Europe. In the material studied here, problems of nomenclature and identification or interpretation of the species have been encountered. The collections from Iberian Peninsula have been classified following the currently accepted limits for the species of the subgenus *Pertusaria*. Two new species, *P. luteola* sp. nov. and *P. werneriana* sp. nov., and new synonymy are proposed. The study of the subgenus *Monomurata*, with 23 species, will be published in the future.

MATERIAL AND METHODS

More than 1000 specimens from the Iberian Peninsula and Balearic Islands have been studied macro and microscopically, 520 of them, have been studied by TLC (ELIX & ERNST-RUSSELL, 1993). Where another author has performed a TLC analysis we give his results. The material was obtained from the following herbaria: BC-Herb.Werner (Institut Botànic de Barcelona), BCC (presently in BCN, herbarium of the Centre Especial de

Biodiversitat Vegetal, Barcelona), Herb. Boqueras (included in BCN), Herb. Etayo (private, Pamplona), Herb. Fiol (Univ. de Balears), JACA (Instituto Pirenaico de Ecología), LEB, MACB, MAF, MUB, SALAF, SANT, SEV-F. Foreign herbaria: ESS, GZU and Herb. Hafellner, H-NYL, HBG, LISU-Herb. Jones, M, Herb. PD-Boom (private, Son, the Netherlands) and WU.

RESULTS

MORPHOLOGY: The most relevant characters of the genus *Pertusaria* are the presence or absence of apothecia, soredia and isidia; the morphology of the apothecia (verruciform or disciform); the number of ascospores per ascus; the arrangement of the spores within the ascus (uniseriate or biseriate) and the wall of the spores. The ascus of the species considered was classified into three groups: single-spored (1 spore), bispored (2 spores) or octospored (5-8 spores) (ARCHER, 1993). The morphology of the spore wall is characteristic of each species. Some species have a simple smooth wall, while others have a double wall, the inner wall being smooth or rough.

CHEMISTRY: Taking into account the combination of lichenic substances and morphological characteristics, there are 23 chemical groups, now placed in two subgenera. In this paper we present the results for subgenus *Pertusaria*.

Species with chloroxanthones

1. coronaton (4,5-dichlorolichexanthone) and stictic and constictic acids: *P. alpina, P. coronata, P. leucostoma, P. pertusa*
2. coronaton (4,5-dichlorolichexanthone) and 2'-*O*-methylperlatolic and confluentic acids: *P. werneriana*
3. only thiophaninic acid: *P. flavida* chem. race 1, *P. plombii, Pertusaria sp.* 1.
4. thiophaninic, stictic and constictic acids: *P. flavicans, P. flavida* chem. race 2, *P. heterochroa, P. pluripuncta, P. rupicola, Pertusaria* sp. 2
5. thiophaninic and planaic acids: *P. paramerae*
6. thiophaninic and norstictic acids: *P. huneckiana, P. luteola, P. praelutescens*
7. thiophaninic and 2'-*O*-methylperlatolic acids: *P. caesioalba, P. flavida* chem. race 3
8. 2-chloro-6-*O*-methylnorlichexantone and stictic and constictic acids: *P. pustulata*
9. granulosin and arthothelin, and gyrophoric and lecanoric acids: *P. dispar*
10. thiophaninic, gyrophoric and lecanoric acids: *P. hymenea* chem. race 1, *P. hymenea* chem. race 3 (null or small concentration of thiophaninic acid).

Species without chloroxanthones

11. norstictic and connorstictic acids: *P. coccodes, P. pseudocorallina*

The main substances are usually associated with secondary metabolites such as cryptostictic acid, constictic acid, hypostictic acid, hypoconstictic acid, menegazziaic acid, connorstictic acid, and some other minor components. These secondary metabolites have been detected in a small number of analyses, and are marked (±).

KEY TO SPECIES ON THE IBERIAN PENINSULA AND BALEARIC ISLANDS

1. Corticolous 2
1. Saxicolous 20

2. Thallus usually greenish-grey or yellowish-grey, UV+ pink, orange or reddish-orange, with xanthones 3

2. Thallus pale greyish-brown, with isidia, UV-, without xanthones. Thallus and isidia K+ red. Isidia simple or branched, with brown apices .... ***P. coccodes***

3. Sterile: sorediated or isidiated 4
3. Fertile 6

4. Thallus KC+ or C+ orange, isidia simple or branched, without brownish apices 5
4. Thallus KC+ or C+ yellow, isidia simple or branched, with brownish apices ....***P. coronata***

5. Thallus K+ red (with formation red crystals) .... ***P. praelutescens***
5. Thallus K+ yellow or brownish-red .... ***P. flavida***

6. Apothecia disciforme or looking as soredia. Disc with or without a superficial layer of dense pruina 7
6. Apothecia verruciforme. Disc opening by a pore or more or less broad open 10

7. Asci with only one spore. Epithecium K+ violet, apothecia irregularly crateriform........... 8
7. Asci octosporate ***(P. hymenea)*** 9

8. Thallus and apothecia with thiophaninic and planaic acids .... ***P. paramerae***
8. Thallus and apothecia with thiophaninic and 2'-*O*-methylperlatolic acids ....***P. caesioalba***

9. Thallus with thiophaninic acid; apothecia with thiophaninic and gyrophoric acids............. .... ***P. hymenea*** cr 1
9. Thallus and apothecia with thiophaninic acid .... ***P. hymenea*** cr 2
9. Thallus and apothecia with thiophaninic and 2'-*O*-methylperlatolic acids ***P. hymenea*** cr 3

10. Asci with 2 spores.. 11
10. Asci with 8 spores.. 17

11. Thallus K+ red (red crystals forming in the medulla) .... ***P. luteola***
11. Thallus K+ yellow or K- 12

12. Disc opening by a pore. Ascospores > de 150 µm long .... ***P. pertusa***
12. Disc opening by a pore or more or less broad open. Ascospores < de 150 µm 13

13. Thallus KC+ yellow (con 2-chloro-6-*O*-methylnorlichexanthone) or thallus KC+ orange (with granulosin and arthothelin).. 14
13. Thallus K+ yellow, C+ or KC+ orange (thiophaninic acid), epithecium K- 15

14. Thallus K+ yellow, C- and KC+ yellow (2-chloro-6-*O*-methylnorlichexanthone), P+ orange; epithecium K+ violet .... ***P. pustulata***
14. Thallus K+ pale yellow, C+ or KC+ orange (granulosin and arthothelin), epithecium K- ....***P. dispar***

15. Ascospores with wall markedly transversally striated.. 16
15. Ascospores with smooth wall .... ***Pertusaria sp. 1***

16. Hymenium C+ red .... ***Pertusaria sp. 2***
16. Hymenium C- .... ***P. heterochroa***

17. Thallus K+ yellow, C+ or KC+ orange (thiophaninic acid) .... ***Pertusaria plombi***
17. Thallus K+ yellow, C- and KC+ yellow (coronaton) 18

18. Thallus P- (coronaton and 2'-*O*-methylperlatolic acid) .... ***P. werneriana***
18. Thallus P+ orange (coronaton and stictic acid) 19

19. Asci with 8 spores. Ascospores uniseriated, 44-65 x 29-32 µm .... ***P. alpina***
19. Asci with 5-6 spores. Ascospores biseriated, 44-90 x 30-40 µm .... ***P. leucostoma***

20. Thallus more or less yellow. UV+ pink, orange or reddish-orange, with xanthones. 21
20. Thallus white, with isidia UV-, thallus without xanthones. Thallus K+ red (red crystals forming in the medulla). Sterile: isidia simple or branched, brown apices .... ***P. pseudocorallina***

21. Thallus sterile, C+ or KC+ orange (thiophaninic acid) 22
21. Thallus fertile, C+ or KC+ orange (thiophaninic acid) or C- (coronaton) 23

22. Thallus sorediated .... ***P. flavicans***
22. Thallus without soredia nor isidia .... ***P. pluripuncta***

23. Asci with 8 spores 24
23. Asci with 2 spores 25

24. Thallus K+ red (thiophaninic and norstictic acids) .... ***P. huneckiana***
24. Thallus K+ yellow (thiophaninic and stictic acids) .... ***P. rupicola***

25. Thallus C- or KC+ yellow (coronaton and stictic acids) .... ***P. pertusa***
25. Thallus C+ or KC+ orange (thiophaninic and stictic acids) .... ***P. pluripuncta***

THE SPECIES

For each species we also quote the binomial used in the herbaria labels and in the bibliographic sources of the Iberian Peninsula (Llimona & Hladun, 2001). Specimens which have been studied by TLC are marked with an asterisk (*).

I. Species with chloroxanthones

1. **Pertusaria alpina** Ahles, (Hepp ex) Ahles, *Pertus. et Conotr.* 12 (1860).

Thallus thin and smooth or somewhat verrucose, cracked, pale greyish to yellow green, lacking soredia and isidia. Apothecia verruciform, generally constricted at the base, 1-2 mm in diam. Ostioles punctiform and pale, 1-3/verruca. Ascospores 8 per ascus, uniseriate, 30-65 x 20-32 μm; wall double, 5 μm thick, with a subtle punctuation. CHEMISTRY: thallus K+ yellow, C-, KC- and P- or P+ orange. Epithecium K- and C-. Coronaton and stictic acid, constictic acid (±) and cryptostictic acid (±).

ECOLOGY: Corticolous (*Fagus sylvatica, Castanea sativa, Malus* and *Quercus pyrenaica* on young branches). Usually found in regions with cold, humid climate, such as mountains in the atlantic area of the septentrional region of the Iberian Peninsula. Some of the older Mediterranean citations could belong to *P. werneriana.*

P. alpina is similar to *P. werneriana*. Only specimens with an evident orange P+ reaction belong to *P. alpina* (the reaction is due to the presence of stictic acid). The identification of the specimens with a P- reaction requires a chromatographic analysis.

Specimens examined. **SPAIN**. **Catalunya**: Lleida, Vall d'Aran, Artiga de Lin, *Fagus sylvatica,* 9.VII.1979, *Gómez-Bolea,* BCN 3313* & BCN 3315.- Lleida, Vall d'Aran, Bosc de Conangles, *F. sylvatica*, 14.IV.1984, *Gómez-Bolea,* BCN 3114.- **Galicia**: A Coruña, Pontedeume, Caaveiro, *Castanea sativa,* 4.VI.1986, *Carballal & López de Silanes,* SANT 2571*.- A Coruña, Pontedeume, Valle del Eume, Caaveiro, *Quercus pyrenaica, Boqueras,* BCN 13145*.- Pontevedra, capital, *Malus,* 7.I.1987, *B. Aguirre,* SANT 6765.

2. Pertusaria caesioalba (Flot.) Nyl., Mém. Soc. Sci. Nat. Cherbourg, 3:180 (1855). *Phlyctis caesioalba* Flot., Bot. Z., 8: 572 (1850).

Thallus thin, white-greyish or with a yellow-brown tinge, continuous or cracked, lacking soredia and isidia. Apothecia numerous, scattered or grouped, crateriform, irregular, not constricted at the base, 0.5-1.5 mm in diam., first punctiform, later irregularly open. Disc black, covered with white thick pruina. Margin concolorous with the thallus, prominent, cracked. Epithecium yellow greenish. Ascospores 1 per ascus, colourless, 140-160 x 50-60 μm, with a double wall, 5-8 μm thick, with subtle transversal striations. CHEMISTRY: thallus K+ pale yellow, C-, KC+ yellow orange P-; epithecium K+ and N+ pink violet. Thiophaninic acid and 2'-*O*-methylperlatolic acid.

ECOLOGY: Corticolous (*Abies pinsapo*).

Morphologically related to *P. ilicicola* Harm. (ascospores 2 per ascus, with thiophaninic acid and 2'-*O*-methylperlatolic acid) and *P. paramerae* A. Crespo & V_zda (ascospores 1 per ascus, with thiophaninic acid, planaic acid and 4-*O*-dimethylplanaic acid).

Specimens examined. **SPAIN**. **Andalucía**, Málaga, Sierra de las Nieves, Cañada del Cuerno, cortijo de los Quejigales, 16.IV.1994, *Abies pinsapo,* Gómez-Bolea & E. Jiménez, BCN 13102*.

3. **Pertusaria coronata** (Ach.) Th. Fr., Lichenogr. Scand. 1: 321 (1871); *Porina coronata* Ach., Lich. Univ.: 310 (1810).

Thallus continuous to verrucose and cracked, greyish-green, sometimes delimited by a white hypothalline line. Isidia concolorous with the thallus, cylindrical or globulous, simple, 0.2-0.5 mm long and 0.1-0.2 mm in diam. Sometimes the isidia breaks at the base and fall away. Apothecia not seen. CHEMISTRY: cortex of the thallus C- and K-, medulla K+ yellow, P+ yellow orange, C-. Thallus UV+ orange. Coronaton, stictic acid, constictic acid (±), cryptostictic acid (±), norstictic acid (±), hypostictic acid (±) and atranorin (±).

ECOLOGY: Corticolous (*Abies alba, Acer opalus* ssp. *granatense, Castanea sativa, Fagus sylvatica, Ilex aquifolium, Olea europaea, Quercus faginea, Q. petraea, Q. pyrenaica*). Found in humid areas in the mountains. Widespread in the central and the septentrional regions of the Iberian Peninsula.

Species *P. flavida* and *P. coccodes* are morphologically similar, but they are easily distinguished by their chemistry.

Specimens examined. **SPAIN**. **Aragón**, Huesca, Valle de Hecho, *Fagus sylvatica,* Boqueras, BCN 13133.- **Asturias**, Cangas, epífita, 31.VIII.1963, Th. Schauer, Herb. M*.- **Castilla y la Mancha**: Albacete, Riópar, Sierra del Calar del Mundo, Fuente de las Raigadas, 17.IX.1984, Egea & Moreno, MUB 6110*.- Guadalajara, Cantalojas, Valle del Sorbe, *Fagus sylvatica,* Burgos, Cardiel & Morales, MACB 30764* & MACB 30766; *Quercus pyrenaica*, MACB 30767.- **Castilla y León**: Burgos, Santo Domingo, epífita, 21.VIII.1962, Th. Schauer, Herb. M*.- León, Ancares, Suárbol, *Q. pyrenaica,* Boqueras, BCN 13135*.- León, Sta Mª. del Sil, *Q. pyrenaica,* 7.V.1984, Terrón, LEB 1537.- León, Puerto del Pando, *Quercus petraea,* 7.IX.1990, Terrón, LEB 1571.- León, Puerto del Pando, *Q. petraea,* Herb. Etayo 5672.- Palencia, Velilla del Río, *F. sylvatica,* Herb. Etayo 5672.- Salamanca, Peña de Francia, 21.IX.1980, *Q. pyrenaica,* Marcos, SALAF 489*.- Salamanca, Nava de Francia, *Castanea sativa,* 29.VI.1980, Marcos, SALAF 502*.- Salamanca, Cereceda de la Sierra, 16.XII.1979, *Quercus faginea,* Marcos, SALAF 501.- Salamanca, Sotoserrano, 14.V.1983, *Olea europaea,* Marcos, SALAF 496.- Soria, Dehesa de Cuevas de Agreda (Moncayo), *Q. pyrenaica,* 5.IX.1984, Gómez-Bolea, BCN 3617*.- **Catalunya**: Lleida, Vall d'Aran, Artiga de Ser, *F. sylvatica,* 9.VII.1979, Gómez-Bolea, BCN 2983*.- Lleida, Vall d'Aran, Bosc de Conangles, *F. sylvatica,* 14.IV.1984, Gómez-Bolea, BCN 3112*.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *Acer opalus* ssp. *granatense,* Boqueras, BCN 13067*.- **Comunidad de Madrid**, Puerto de Canencia, *Ilex aquifolium,* 15.IX.1981, Bueno, Crespo & Merino, MAF 694*.- **Galicia**, Ourense, Poba de Trives, *Q. pyrenaica,* Boqueras, BCN 13134.- **Navarra**, Larra, Valle del Roncal, *Abies alba,* 19.VII.1973, Llimona, BCN 2503*, JACA sn* & JACA 1360*.

4. **Pertusaria dispar** J. Steiner, Österr. Bot. Z. 67: 279 (1918).

Thallus more or less smooth, cracked to verrucose, whitish to yellow green, lacking soredia and isidia. Apothecia verruciform, dispersed, not constricted at the base. Ostioles punctiform or somewhat open and pale, 1-3 per verruca. Ascospores 2 per ascus, subuniseriate, 80-110 x 28-50 μm, wall double, rough, markedly transversally striated. CHEMISTRY: thallus K+ pale yellow, C+ and KC+ orange (this reaction in very intense in the yellow thalli and less intense in the whitish ones) and P-; epithecium K- or K+ yellow and C+ red. Arthothelin, granulosin, gyrophoric and lecanoric acids.

ECOLOGY: Corticolous. Found only in Portugal and Balearic Islands. Some Spanish citations of this taxon (CARBALLAL *et al*. 1983) correspond to *Pertusaria* sp. 1 (similar to *P. heterochroa* but with unstriated ascospores). This is discussed under *P. heterochroa.*

Specimens examined. **SPAIN**. **Balears**: Cabrera, Picamosques, branques seques, 20.VIII.1991, Herb. Fiol 616*.- Formentera, Casa Campanic, *Pinus,* ESS-Feige 4745*, *Juniperus phoenicea,* ESS-Feige 4711*.- Mallorca, Valldemosa font de S'Abernada, *Quercus ilex,* IX.1983, Herb. Fiol 101-2II*.- Menorca, Ciutadella, Cala d'Algaiarens, 5.VII.1993, *Juniperus,* Boqueras, BCN 13123*.
PORTUGAL. **Beira Alta?**, Bàrro, *Arbutus,* III.1890, Menyharth, (WU*, chrom. by Hanko).

5. **Pertusaria flavicans** Lamy, Bull. Soc. Bot. France 25: 427 (1878); = *P. flavicans* var. *flavicans*; = *P. flavicans* var. *coudercii* (Harm.) Erichsen; = *P. coudercii* Harm.; = *P. flavicans* var. *schistosa* Erichsen.

Thallus generally well delimited, cracked-areolate, some thalli with flattened and angular areoles of up to 1 mm in diam., others with highly convex areoli, irregularly rounded of up to 2 mm in diam., greyish yellow or greyish green. Round, dispersed to confluent soralia, more pale than the thallus or with soredia-like isidia, concolorous with the thallus. Apothecia absent. CHEMISTRY: thallus K-, KC+ and C+ orange, P-. Thiophaninic acid, stictic acid, constictic acid, cryptostictic acid, norstictic acid, menegazziaic acid (±), hypostictic acid (±), atranorin (±).

ECOLOGY: A saxicolous and silicicolous taxon, growing on moderately lit, scarcely sloping surfaces, intermediate or highly photophilous, more or less nitrophilous, with an optimum on plane or gently sloping siliceous surfaces, in the supramediterranean and montane belts (al. *Pertusarion leucosorae* Egea & Llimona, 1987, as. *Pertusarietum leucosoro-flavicantis* Wirth, 1972).

Specimens examined. **SPAIN**. **Andalucía**, Almería, Gérgal, Sierra de Filabres, Arroyo Verruga, 20.IX.1979, Egea, MUB 486*.- **Castilla y León**, León, Cerro Peral, pizarra, 24.VI.1989, Terrón, LEB 640.- **Catalunya**: Barcelona, Montseny, Turó Catiu d'Or, roca metamòrfica, 30.VIII.1979, Hladun, BCN 2698.- Barcelona, Montseny, Llimona & Corbín, SEV-F sn.- Girona, Núria-Ribes de Freser, Hafellner, GZU-Haf. 17369*.

6. **Pertusaria flavida** (DC.) J.R. Laundon, Lichenologist 2(2): 144 (1963); *Variolaria flavida* DC., in Lam. & DC., Fl. Franc., 3. Aufl. 6: 177 (1815); = *P. lutescens* (Hoffm.) Lamy; = *P. servediata* Nyl.

Thallus thin and cracked, well delimited, yellow-greenish. Fully covered by isidia, cylindrical or globulous, simple, branched or becoming coralloid, 0.1-0.5 mm long and 0.1 mm in diam. and with small apical soredia. Isidia decorticate at the tip, powdery. Apothecia not seen. CHEMISTRY: thallus K-, KC+ and C+ orange, P-. **Chemical race 1** (8%): thiophaninic acid; **chemical race 2** (75%): thiophaninic acid, stictic acid, cryptostictic acid (±), menegazziaic acid (±) and norstictic acid (±); **chemical race 3** (17%): thiophaninic acid, 2'-O-methylperlatolic acid and norstictic acid (±).

ECOLOGY: Corticolous (*Abies alba, Betula celtiberica, Castanea sativa, Ceratonia siliqua, Fagus sylvatica, Olea europaea, Pinus pinea, P. sylvestris*, *Quercus ilex* ssp. *ballota, Q. petraea, Q. pyrenaica, Q. robur, Q. x rosacea, Q. suber*), in humid and shaded habitats. Widespread in mountain areas of the Iberian Peninsula.

Easily identified by the KC+ and C+ orange reaction of the thallus and by the presence of sorediiferons isidia. Habitus similar to *Pertusaria coccodes* and *P. coronata* (see discussion of *P. coronata* and *P. praelutescens*).

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Jerez de la Frontera, *Quercus suber,* Sequeiros & Rowe, SEV-F 5856*.- Cádiz, Alcalá de los Gazules, *Q. suber,* Sequeiros & Rowe, SEV-F 5309* & SEV-F 5404*.- Cádiz, Carretera de Ubrique a Puerto de Galis, Mojón de la Viuda, 17.IV.1994, Gómez-Bolea & E. Jiménez, *Q. suber,* BCN 13225.- **Aragón**: Huesca, Jaca, Oza, *Abies alba,* 18.VII.1973, Llimona, BCN 2500.- Huesca, Selva de Oza, *Fagus sylvatica,* Boqueras, BCN 13144.- **Asturias**, Covadonga, Picos, 12.VIII.1962, Schauer, Herb. M *.- **Castilla y León**: Burgos, Huidobro, *Quercus pyrenaica,* Burgaz, MACB 30316.- León, Matachana, *Castanea sativa,* Terrón, MAF 3338.- León, Bárcena de la Abadía, *Quercus ilex* ssp. *ballota,* 4.IV.1990, Terrón, LEB 2360.- León, Peredilla, *Q. pyrenaica,* 22.VIII.1986, Terrón, LEB 1534.- León, Puente de Domingo Florez, *Q. suber,* 4.I.1994, Terrón, LEB 2035.- León, Campo del Agua, *Quercus x rosacea,* 23.VII.1990, Terrón, LEB 2290.- León, Sorribos de Alba, *Q. pyrenaica,* 8.VIII.1986, Terrón, LEB 1533.- León, Lusio, *C. sativa,* 21.XII.1986, Terrón, LEB 1550-1558.- León, Paradaseca, *C. sativa,* 21.XII.1986, Terrón, LEB 1555-1559.- León, Mansilla de las Mulas, *Q. ilex* ssp. *ballota,* Burgaz & Fuertes, MACB 34001.- León, Puerto de Lumeras, *C. sativa,* 13.XII.1986, Terrón, LEB 1540.- León, Matachana, *C. sativa,* 4.V.1984, Terrón, LEB 1538.- León, Villadecanes, *C. sativa,* 14.XII.1986, Terrón, LEB 1544 & 1541.- León, Vega de Valcarce, *C. sativa,* 14.XII.1986, Terrón, LEB 1539.- León, Parajís, *C. sativa,* 14.XII.1986, Terrón, LEB 1557.- León, Balboa, *C. sativa,* 14.XII.1986, Terrón, LEB 1552 & LEB 1553.- León, Villanueva de Valdueza, *C. sativa,* 20.XII.1986, Terrón, LEB 1546 & LEB 1549.- León, Burbia, *C. sativa,* 20.XII.1986, Terrón, LEB 1543.- León, Puerto del Pando, *Quercus petraea,* Herb. Etayo 5672.- Salamanca, Las Batuecas, 24.IV.1983, *Prunus avium,* Marcos, SALAF 522.- Salamanca, Fuentes de Béjar, 16.XI.1980, *Pinus pinea,* Marcos, SALAF 511.- Salamanca, Peña de Francia, 30.V.1982, *Pinus sylvestris,* Marcos, SALAF 507*.- Salamanca, Tamames, 21.IX.1980, *Q. ilex* ssp. *ballota,* Marcos, SALAF

508.- Salamanca, Sequeros, 19.III.1981, *Q. pyrenaica,* Marcos, SALAF 510.- Soria, Dehesa de Cuevas de Agreda, Moncayo, *Q. pyrenaica,* 5.IX.1984, Gómez-Bolea, BCN 3617.- **Castilla y La Mancha**: Ciudad Real, Mestanza, *Q. pyrenaica,* Sarrión, MACB 43941*.- Ciudad Real, Fuencaliente, Sierra de Dormideros, *Quercus ilex* ssp. *ballota,* Sarrión, MACB 43944.- Ciudad Real, Río Cereceda, *Q. pyrenaica,* Sarrión, MACB 43946.- Ciudad Real, Peña Rodrigo, *Q. suber,* Sarrión, MACB 43945; *Quercus* sp., MACB 43942.- Guadalajara, Cantalojas, Valle del Lillas, *F. sylvatica,* Burgos & Cardiel, MACB 30763.- Toledo, Hontanar, *Q. pyrenaica,* Burgaz, MACB 30322.- Toledo, Navamorcuende, Cruces, *Q. pyrenaica,* Vázquez & Burgaz, MACB 60333.- Toledo, San Pablo de los Montes, *Q. suber,* MACB 40667.- **Catalunya**: Girona, Alt Empordà, La Vajol, *Q. suber,* 13.X.1985, Boqueras, BCN 3861.- Tarragona, La Sénia, Barranc del Retaule, 10.II.1991, *P. sylvestris,* Boqueras, BCN 13069.- **Cantabria**, Luriezo, *C. sativa,* 7.IX.1990, Terrón, LEB 1570.- **Comunidad de Madrid**: Puerto de Canencia, *Betula celtiberica*, 15.IX.1981, Bueno, Crespo & Merino, MAF 695.- Montejo de la Sierra, *Q. pyrenaica*, 5.V.1973, Crespo, MAF 1793*.- **Euskadi**: Alosua, IV.1953, J. Poelt, Herb. M.- Araba, Landa, *Quercus robur*, 1.VIII.1983, B. Aguirre, MAF 696.- **Galicia**: A Coruña, Carballeira de San Lorenzo, *Q. robur*, 7.V.1984, Carballal & López de Silanes, Intercambio liquenológico 1, BCN 1827* & MACB 16752.- A Coruña, Carballeira de San Lorenzo, *Q. robur,* 7.V.1984, Carballal & López de Silanes, MAF 2951.- Lugo, Ancares, 20.VI.1992, López de Silanes & Carballal, SANT 8847.- Ourense, Poba de Trives, *Q. pyrenaica,* Boqueras, BCN 13136.- **La Rioja**: Puerto de Piqueras, *F. sylvatica,* Burgaz & Fuertes, MACB 33999.- Posadas, *Q. pyrenaica,* Burgaz & Fuertes, MACB 34000.- **Navarra**: Rincón de Belagua, *F. sylvatica,* 1973, Llimona, JACA sn*.- Roncesvalles, 31.VIII.1963, Schauer, sub. *P. lutescens,* Herb. M *.- Larra, Valle del Roncal, *Abies alba,* 19.VII.1973, Llimona, BCN 2499.
PORTUGAL. **Alentejo**, Vidigueira, Cucufate, Vila de Frades, *Olea europaea,* Herb. M. P. Jones*.- **Algarve**: Monchique, Casais, *Q. suber,* P.v.d. Boom 947.- Caldas de Monchique, *Q. suber,* P.v.d. Boom 910.- Vale de R. Merces, S. de Querença, *C. sil.,* Herb. M. P. Jones.- **Beira ?**, Serra da Estrella, 3.VIII.1963, Schauer, Herb. M*.- **Beira Alta**: Caramilinho-Cabeca da Nave, *C. sativa,* Herb. M. P. Jones*.- Folgozinho, 17.IX.1968, Tavares, GZU*.- Chaos Guarda, *C. sativa*, 27.IX.1964, Tavares, Lich. Lusit. Exs. 213, Herb. M * & GZU.- **Beira Baixa**: Covilha, 22.IX.1983, Brunner, GZU* chrom. by E. Schreiner.- Tejo, 22.IX.1983, Brunner, Herb. Hafellner* & GZU*.- **Minho**, Póvoa de Lanhoso, Fuente-Arcada, X.1921, Sampaio, Lich. Portugal 159 sub. *P. lutescens,* Herb. M *.- NE Braga, Geres, *Quercus,* P.v.d. Boom 6432.

7. **Pertusaria heterochroa** (Müll. Arg.) Erichsen, Rabenh. Krypt.-Fl. 9, 5, (1): 490 (1936); *Pertusaria pustulata* (Ach.) Duby var. *heterochroa* Müll. Arg., Flora 67: 285 (1884); = *P. maximiliana* Klem., Nova Hedwigia 9: 482 (1965).

Thallus more or less verrucose, cracked, greyish green or yellowish green, lacking soredia and isidia. Apothecia verruciform, dispersed, not constricted at the base. Ostioles pale brown, punctiform or somewhat open, 3-6 per verruca. Ascospores 2 per ascus, (60) 90-120 x (22) 38-45 μm, double wall, rough, markedly transversally striated. CHEMISTRY: thallus K+ pale yellow and KC+ orange. Thiophaninic acid, stictic acid, cryptostictic acid (±), constictic acid (±), hypostictic acid (±), hypoconstictic acid (±), menegazziaic acid (±), norstictic acid (±). Lichen substances in the type specimen of *P. maximiliana*: thiophaninic acid, stictic acid and constictic acid (±).

ECOLOGY: Corticolous (*Castanea sativa, Ceratonia siliqua, Ficus carica, Juniperus phoenicea, Laurus nobilis, Olea europaea, Pinus halepensis, Pistacia lentiscus, Prunus dulcis, Punica granatum, Quercus coccifera, Q. ilex, Q. robur, Q. rubra, Q. suber*), thermophilous, neutrophilous in lichenic communities on branches and young trunks, mainly in open and sunny conditions. It forms small thalli, in the lichen associations *Dirinetum ceratoniae* Klem., 1965 and *Lecanoro hybocarpae-Caloplacetum pollinii* Llimona, Giralt, Boqueras & Gómez-Bolea, 1996 (BOQUERAS, 2000). Distributed along the Mediterranean coast and littoral lowlands, with a disjunct occurrence in Portugal.

P. maximiliana Klem. (KLEMENT, 1965) shares similar characters of thallus form, apothecia, ascospores, chemistry and ecology with *P. heterochroa*. The only difference, a yellow thallus, is not sufficient to place it in a different taxon. Another species, *P. dispar*, also has yellow to whitish-green thalli, but differs from *P. heterochroa* in the presence of different xanthones and gyrophoric acid (hymenium C + red).

Pertusaria sp. 1 is similar to *P. heterochroa* but has smaller spores (65-85 x 30-40 μm) with a smooth double wall and Atlantic distribution. The specimens named here as *Pertusaria* sp. 1 are very poor and were collected in a single location. We have included these specimens in *P. heterochroa*. A more accurate classification may be possible in the future if additional material becomes available.

The specimens from Valencia, cited as *Pertusaria* sp. 2 (MAF 701 and MAF 1742) present the same morphology and chemistry (thiophaninic and stictic acids) as *P. heterochroa*, but differ from this species by the presence of dark ostioles and the C + red reaction of the epithecium. TLC has not detected gyrophoric acid in its thalli.

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Barbate de Franco, *Quercus coccifera*, Egea, MUB sn.- Cádiz, Tarifa, *Pistacia*, Egea & Alonso, MUB sn*.- Málaga, Manilva, *Pistacia*, MUB sn*.- **Balears**: Eivissa, Cala Llonga. *Pinus*, 9.IX.1960, Klement, Herb. M* (Type and Syntype of *P. maximiliana*).- Eivissa, Sant Miquel, ESS-Feige 13733*.- Formentera, *Pinus*, 27.XII.1967, Llimona, BCN 160.- Menorca, Basilica Torrelo, *Olea*, ESS-Feige 9281*.- Menorca, Cala Galdana, *Pistacia lentiscus*, ESS-Feige 9194*.- Menorca, Ciutadella, Cala en Bastó, 1.VII.1993, Boqueras, *Pinus halepensis*, BCN 13075*.- Menorca, Fornells, 4.VII.1993, Boqueras, *Olea*, BCN 13076*.- Menorca, Mercadal, Toro, 4.VII.1993, Boqueras, *Olea*, BCN 13074*.- Cabrera, Canal Llarg, *Olea europaea* var. *sylvestris*, 19.VII.1991, Herb. Fiol 483*.- Mallorca, Felanitx, *Olea*, P.v.d. Boom 18517.- Mallorca, Campos, Ses Sitjoles Seques, *Opuntia maxima*, II.1987, Herb. Fiol 368*.- Mallorca, Pineda de la baixada a l'Olla, *P. lentiscus*, 1991, Herb. Fiol 506.- Mallorca, Loc?, *Juniperus phoenicea*, ESS-Feige 6696*.- Mallorca, Las Gaviotas, *Pinus*, ESS-Feige 6756*.- Mallorca, Cala Fiyriere?, *P. lentiscus*, ESS-Feige 7168*.- Mallorca, Formentor, *Quercus ilex*, ESS-Feige 7149*.- **Catalunya**: Girona, Les Gavarres, *Q. ilex*, Gómez-Bolea, BCN 3316*.- Girona, Tossa, Frey-HBG 4194; Blanes-Tossa, *P. lentiscus*, Frey 4263, HBG* (chrom. by Hanko).- Girona, Begur, Sa Tuna, *Quercus suber*, 13.X.1985, Boqueras, BCN 3865*.- Girona, La Selva, Tossa, Cala Bona, *Q. suber*, 24.VII.1985, Boqueras, BCN 3866.- Girona, Figueres, *Q. suber*, 30.III.1953, Doppelbaur, Herb. M.- Tarragona, Perelló, punta Minyana, 29.III.1991, *Ceratonia siliqua*, Boqueras, BCN 13078*.- Tarragona, Amposta, entre la síquia del Francès, 14.VI.1985, *Punica granatum*, Boqueras, BCN 13077.- Tarragona, Amposta, barranc de Sonyé, 15.V.91, *C. siliqua*, Herb. Boqueras 307.- Tarragona, Amposta, direcció Masdenverge, vora la casa del Francès, 30.V.1991, *C. siliqua*, Herb. Boqueras c80, c84, c85.- Tarragona, La Galera, carretera de Sta. Barbara a la Galera, 30.V.1991, *Prunus dulcis*, Herb. Boqueras c96.- Tarragona, El Godall, per dalt del poble, 30.V.1991, *P. dulcis*, Herb. Boqueras c173.- Tarragona, Sant Carles de la Ràpita, barranc del Solito, 25.VII.1986, *Q. ilex*, Herb. Boqueras 110.- Tarragona, Sant Carles de la Ràpita, sota la lloma de la Burga, 25.VII.1986, *Q. ilex*, Herb. Boqueras 107.- Tarragona, El Terrer, *C. siliqua*, II.1985, M. Giralt, BCN 2194.- **Galicia**: Pontevedra, Lourizan, *Castanea sativa*, 13.IV.1982, SANT 1054 (*Pertusaria* sp. 1).- Pontevedra, Lourizan, *Quercus robur*, 13.IV.1982, SANT 1052 (*Pertusaria* sp. 1).- Pontevedra, Lourizan, *Quercus rubra*, 13.IV.1982, SANT 1053 (*Pertusaria* sp. 1).- **País Valencià**: València, Alzira, La Murta, *Laurus*, 3.V.1981, Atienza, MAF 162.- València, El Saler, *Pinus halepensis*, MAF 701* (*Pertusaria* sp. 2); *Quercus coccifera*, 19.II.1980, Corbín, MAF 1742* (*Pertusaria* sp. 2).

PORTUGAL. **Algarve**: Vale de Boi, *Ficus carica*, P.v.d. Boom 14573*; *P. dulcis*, P.v.d.Boom 14556*.- 14 km WSW of Lagos, *C. siliqua*, P.v.d. Boom 14675.- Portimao, Quinta troia, *Ficus*, Herb. M. P. Jones*.- Tavira, Abril 1961, Poelt, GZU.- **Beira Alta?**, Bàrro, Menyharth, WU* (chrom. by Hanko).- **Estremadura**: Praia do Guincho, *P. halepensis*, 3.X.1963, Tavares, Lich. Lusit. Exs. 239, Herb. M* sub *P. maximiliana*.- id., GZU*, sub *P. maximiliana*.- Armacao de Pera, *Ficus carica*, P.v.d. Boom 828*.

8. **Pertusaria huneckiana** Feige & Lumbsch, Bibl. Lichenol. 53: 174 (1993).

Thallus thick, cracked-areolate and verrucose, grey-greenish or yellow-green, lacking soredia and isidia. Apothecia round, 1-3 mm in diam., numerous and tight. Margin thick, smooth and concolorous with the thallus. Disc black, initially punctiform and later open, 1.5 mm in diam.. Ascospores (6)-8 per ascus, with a double and smooth wall, 70-100 x 30-50 μm. CHEMISTRY: thallus and margin of the apothecia K+ red, C+ and KC+ orange and P+ red orange. Epithecium K+ red violet and C+ red violet. Thiophaninic acid and norstictic acid (stictic acid is not detected by TLC).

ECOLOGY: A saxicolous and silicicolous taxon; so far known only from Menorca (Balearic Islands).

This species is morphologically similar to *P. rupicola,* but it has a different chemistry. According to LUMBSCH *et al*. (1993), *P. huneckiana* contains thiophaninic and norstictic acids as major lichen compounds and stictic acid as minor compound. In contrast, *P. rupicola* contains thiophaninic and stictic acids as major compounds and norstictic acid as minor compound. According to Archer (*in litt.*) and to our own analysis, stictic acid was not detected by TLC in *P. huneckiana*. Both taxa are separated from *P. pluripuncta* by the number of ascospores in the ascus: two per ascus for *P. pluripuncta* and eight per ascus for *P. huneckiana* and *P. rupicola*. *P. rupicola* contains high levels of stictic acid but same specimens from Catalunya also contains significant traces of norstictic acid in the amphithecium. However stictic acid is absent from *P. huneckiana*.
Specimens examined. **SPAIN**. **Balears**, Menorca, Roca de s'Indio, ESS-Feige 11133* & ESS-Feige 11069 (typus).

9. **Pertusaria hymenea** (Ach.) Schaer., Lich. Helv. Spicil. Set. 7: 353 (1836); *Lichen hymeneus* Ach., Lich. Suec. Prodr.: 80 (1798); = *P. lecanorodes* Erichsen; = *P. wulfenii* DC.; = *Thelotrema hymeneum* Ach.

Thallus thick, cracked, areolate and verrucose, grey-greenish or yellow-green, without zonation at the margin, sometimes smooth, thin and dark greenish-grey; soredia and isidia absent. Apothecia in lecanorine verrucae, 1-2 mm diam., 1-(2) per verruca, normally constricted at the base, disc initially punctiform, later open, up to 0.5 mm in diam. Some specimens have closed verrucae. Ostioles black and matt to yellow pale brown. Ascospores 6-8 per ascus, 70-100 x 30-50 μm, double wall, the inner with or without zonation and the outer with minute to coarse dots. CHEMISTRY: thallus K+ pale yellow, KC+ intense yellow to orange, C- or C+ yellow or orange and P-; black epithecium K+ red violet and C+ red, and colourless or pale brown epithecium C- always showing the reaction in lateral area of the disc. **Chemical race 1** (48%): thiophaninic acid, gyrophoric acid, lecanoric acid and orsellinic acid; **chemical race 2** (5%): thiophaninic acid and 2'-*O*-methylperlatolic acid; **chemical race 3** (33%): thiophaninic acid. Thalli without lichen substances (14%).

ECOLOGY: Corticolous (*Acer opalus* ssp. *granatense, Ceratonia siliqua, Cercis auatralis, Corylus avellana, Fagus sylvatica, Ilex aquifolium, Olea, Pistacia lentiscus, Quercus faginea, Q. ilex, Q. ilex* ssp. *ballota, Q. pyrenaica, Q. robur*, *Q. suber*). According to our own observations, the specimens with open fertile verrucae have a thick thallus and are found on rough bark, supporting well developed lichen communities (with *Pertusaria pertusa, P. albescens* and foliose thalli such as *Physconia* sp. pl. and heliophytes species). The samples with a closed ostiole and thinner thallus grow on the smooth bark of *Corylus* and *Ilex,* in humid and shaded habitats along with some species of the *Graphidion* alliance. Widespread in the Iberian Peninsula.

Diagnostic characters: thiophaninic acid, asci with 8 ascospores and apothecia in lecanorine verrucae. The morphology and chemistry are otherwise variable.

Morphologically the specimens examined can be divided into two groups:

1. Thallus up to 1 mm thick, becoming gradually separated from the bark; ostioles open, black or pale brown, variable chemistry, including the 3 chemical races cited above. Some forms with pale ostioles could belong to *P. cyparissi* Körb. but an examination of foreign material of this taxon showed a gradation of the ostiole colour and we have included such material (with pale ostioles) in *P. hymenea*.

2. Thallus thin and dark, remaining adherent to the bark, with fertile verrucae rarely constricted at the base, more or less closed, with dark ostioles; chemical race 3 only. Although the epithecium gave C+ red reaction, gyrophoric acid was not detected by TLC. Some specimens from Morocco (Werner's herbarium sub *P. leioplaca* f. *plumbea* Harm.) correspond to this dark form.

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Facinas, S. de Salaviciosa, *Quercus suber*, Sequeiros & Rowe, SEV-F 5396*.- Cádiz, Alcalá de los Gazules, epifítica, Sequeiros & Rowe, SEV-F 5402*, SEV-F 5327*.- Cádiz, Jerez de la Frontera, Canto del Caballo, 18.IV.1994, *Pistacia lentiscus*, Gómez-Bolea & E. Jiménez, BCN 13124*.- Cádiz, Tarifa, IV.1953, J. Poelt, Herb. M*.- **Aragón**, Huesca, Selva de Oza, *Fagus sylvatica*, Boqueras, BCN 13126*.- **Asturias**, Covadonga, epífita, 11.VIII.1962, Th. Schauer, Herb. M*.- **Balears**: Mallorca, 16.IV.1963, ex herbarium Lambinon, BCN 62* (the only specimen with thiophaninic and 2'-O-methylperlatolic acids).- Mallorca, Sóller, entrada a ca Monnaber, 13.VII.1994, Herb. Etayo 12506*.- Mallorca, Puig Major, 9.IV.1964, Ch. & J. Poelt, Herb. M* .- Mallorca, Sóller-Lluc km 40, propietat Monnaber, *Quercus ilex* ssp. *ballota*, 13.VII.1994, Etayo 12506.- Mallorca, Valldemossa, *Quercus ilex*, ESS-Feige 7459.- **Cantabria**, Otáñes, Castro Urdiales, 9.VIII.1962, Th. Schauer, Herb. M*.- **Castilla y León**: Burgos, Caniego, *Quercus faginea*, 12.VII.1983, B. Aguirre, MAF 1790.- Salamanca, Herguijuela de la Sierra, 14.XI.1982, *F. sylvatica*, Marcos, SALAF 526.- **Catalunya**: Barcelona, Sant Llorenç del Munt, La Castellassa, *Q. ilex*, Boqueras, BCN 13227*.- Tarragona, La Sénia, Barranc del Racó de l'Avellanar, 1.XI.1990, *Acer opalus* ssp. *granatense*, Herb. Boqueras d195x.- Tarragona, La Sénia, Barranc del Retaule, 18.VII.1985, *Ilex aquifolium*, Herb. Boqueras 196.- Tarragona, La Sénia, el Negrell, 1.XII.1984, *Corylus avellana*, Herb. Boqueras d243*.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *A. opalus* ssp. *granatense*, Boqueras, BCN 13080, *Q. ilex*, Boqueras, BCN 13079, *C. avellana*, Herb. Boqueras d241.- **Euskadi**: Guipúzcoa, Arno, Motriko, *Q. ilex*, 4.XII.1983, B. Aguirre, MAF 1789*.- Guipúzcoa, Basemia, Azkerazo-Kapoleta, *Quercus pyrenaica*, 10.IV.1983, B. Aguirre, MAF 1811*.- **Galicia**, A Coruña, Mañón, Grañas, *Quercus robur*, 20.II.1988, A. Garci, SANT 6527.- **Navarra**, Punta Urrizate, *Q. robur*, Herb. Etayo 2941*.
PORTUGAL. **Algarve**: Aquas de Monsaigne, 1866, H. Solms, Herb. M*. - Tavira, Poelt, GZU* (chrom. by Hanko).- Vale de R. Merces, S. de Querença, *Ceratonia*, Herb. M. P. Jones.- **Beira Alta**, N de San Pedro do Sul, *Olea*, Herb. M. P. Jones*.- **Estremadura**: Lisboa, Palacio de Correio, *Cercis*, Herb. M. P. Jones.- Setúbal, *Ficus*, P.v.d. Boom 6648.- **Minho**: NE Braga, Geres, *Ilex*, P.v.d. Boom 6478*, 6439*.- Póvoa de Lanhoso, S. Gens, III.1923, Sampaio, Lich. Portugal 158, Herb. M*.

10. Pertusaria leucostoma (Bernh.) A. Massal., Ricerch. Auton. Lich. Crost.: 188 (1852); *Sphaeria leucostoma* Bernh., in Roemer, Arch. Bot. 2(1): 11 (1800); = *P. leioplaca* (Ach.) DC., in Lam. & DC., Fl. Franç. 3. Aufl. 6: 173 (1815).

Thallus thin, smooth or slightly verrucose and continuous or cracked, yellow green or grey greenish, lacking soredia and isidia. Apothecia verruciform, scattered, rarely confluent, not constricted at the base, vertical or somewhat constricted, 0.8-2 mm in diam. Ostiole punctiform or slightly open in the larger ones, greyish or brownish, 1-3/verruca. Ascospores 3-4-(6) per ascus, 70-90 x 25-38 μm, with a double wall and subtle transversal striations. Towards the poles of the spores, the wall may have transversal zonation. CHEMISTRY: thallus K+ yellow and KC+ yellow or KC-, C- and P- or P+ orange.

Chemical race 1 (86%): coronaton and stictic acid, cryptostictic acid (±) and norstictic acid (±). **Chemical race 2** (14%): coronaton.

ECOLOGY: Corticolous (on smooth bark of *Acer opalus* ssp. *granatense, Acer* sp., *Alnus glutinosa, Castanea sativa, Celtis australis, Corylus avellana, Fagus sylvatica, Nerium oleander*, *Pistacia* sp., *Quercus coccifera, Q. faginea, Q. ilex, Q. pyrenaica, Q. suber, Sorbus aria, Tilia cordata*). According to our observations it is abundant in shaded, deciduous forests. It belongs to the *Graphidion scriptae* Ochsner, 1982 alliance, usually associated with *Lecanora intumescens*. Widespread in the Iberian Peninsula.

Diagnostic characters for this species are: coronaton content, ascospore (2)-3-4-(8) per ascus and variable fertile verrucae of wide straight or somewhat constricted base. The two related species *P. alpina* and *P. werneriana* are distinguished by their 8-spored asci and in the case of *P. werneriana,* (q.v.) by the presence of 2'-*O*-methylperlatolic acid.

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Jerez de la Frontera, Canto del Caballo, 18.IV.1994, *Nerium oleander,* Gómez-Bolea & E. Jiménez, BCN 13081*.- Cádiz, Algeciras-Tarifa, *Quercus suber,* 7.IV.1953, Doppelbaur, Herb. M*. - Cádiz, Tarifa, Sierra del Cabrito, *Pistacia,* 8.IV.1990, Egea & Alonso, MUB sn.- Cádiz, Barbate de Franco, Sierra Retún, Caños de Meca, *Quercus coccifera,* 8.IV.1990, Egea, MUB sn.- Málaga, Manilva, *Pistacia,* Egea, MUB sn.- **Asturias**: Covadonga, *Fagus sylvatica,* 12.VIII.1962, Th. Schauer, Herb. M*.- Covadonga, *Acer,* 11.VIII.1962, Th. Schauer, Herb. M*.- **Castilla y León**: Burgos, Villamudria, *Quercus pyrenaica,* Burgaz, MACB 42552.- León, Burbia, *Castanea sativa,* 20.XII.1986, Terrón, LEB 1542.- León, Prioranza del Bierzo, *C. sativa,* 18.X.1988, Terrón, LEB 2175.- Salamanca, Linares de Riofrio, *Alnus glutinosa,* Marcos, SALAF 1337.- Salamanca, Valero, 10.II.1980, *Celtis,* Marcos, SALAF 146*.- Salamanca, Las Batuecas, 24.IV.1983, *Alnus glutinosa,* Marcos, SALAF 523.- Salamanca, Navasfrías, *Q. pyrenaica,* Marcos, SALAF 215.- **Castilla y La Mancha**: Ciudad Real, Fuencaliente, Río Cereceda, *Quercus faginea,* Fuertes & Sarrión, MACB 43952.- Guadalajara, Cantalojas, Valle del Sorbe, *F. sylvatica,* Burgos, Cardiel & Morales, MACB 30765*.- **Catalunya**: Girona, Figueras, *Q. suber,* 30.III.1953, Doppelbaur, Herb. M*.- Tarragona, La Sénia, Barranc del Retaule, 9.II.1991, *Acer opalus* ssp. *granatense,* Herb. Boqueras a1, a41, *F. sylvatica,* Herb. Boqueras 193, 194, d319, *Sorbus aria,* Herb. Boqueras a177.- Tarragona, La Sénia, el Negrell, 1.XII.1984, *Corylus avellana,* Herb. Boqueras d241, d244, d245.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *C. avellana,* Herb. Boqueras d211.- Tarragona, Alt Camp, Aiguamúrcia, *Quercus ilex,* 20.II.1988, M. Giralt, BCN 13082*.- Tarragona, Barranc de Planelles, *Prunus dulcis*?, 5.XI.1988, M. Giralt, BCN 13083*.- Tarragona, Benifallet, *Q. ilex,* 6.XI.1988, M. Giralt, BCN 13084*.- Tarragona, Barranc de Montalt, *Q. ilex,* 2.VI.1988, M. Giralt, BCN 13085*.- Tarragona, Priorat, La Torre de Fontaubella, *C. avellana,* 13.XI.1987, M. Giralt, BCN 13086*.- Tarragona, Vandellós, Barranc dels Avellans, *Q. ilex,* 1.VI.1988, M. Giralt, BCN 13087*.- **Comunidad de Madrid**, Montejo, *F. sylvatica,* XII.1972, Crespo & Barreno, MAF 2098*.- **Galicia**, Ourense, Sierra del Invernadeiro, Ribeira Pequeña, *Acer,* 24.IV.1988, Carballal, SANT 7686.- **La Rioja**, Ezcaray, *Fagus*, 21.VIII.1962, Th. Schauer, Herb. M*.- **País Valencià**, Castelló, Pobla de Benifassà, barranc de l'Avellanar, 21.X.1990, *A. opalus* ssp. *granatense,* Boqueras, BCN 13089.
PORTUGAL. **Beira Alta?**, Bàrro, Menyharth, WU.- **Ribatejo**, Fatima, *Quercus,* 4.VIII.1963, Th. Schauer, Herb. M*.

11. Pertusaria luteola Boqueras sp. nov.
Thallus laevis, tenuis, griseoviridescens vel luteoviridescens, isidiis et sorediis destitutus; apothecia verruciformia, numerosa, in verrucis singula, thallo concoloria, plano-subhemisphaerica, 0.5-0.8 mm in diam.; ostiola punctiformia, fusca; sporae 2nae, uniseriatae, ellipsoideae, parietibus interioribus transverse undulatis, 70-95 μm longae, 25-35 μm latae. Corticola. Thallus acidum thiophaninicum et acidum norsticticum continens.
TIPUS: Hispania, Castilla y León, León, Suárbol, *Quercus pyrenaica,* Boqueras, BCN 13140*.-

Thallus smooth, cracked, thin, grey-greenish or yellow-green, lacking soredia and isidia. Apothecia verruciform, dispersed, not constricted at the base, 0.5-0.8 mm in diam. Ostioles punctiform, dark, 100-200 μm, 1 per verruca. Epithecium dark, green or blackish. Ascospores 2 per ascus, ellipsoid, 70-95 x 25-35 μm, with a double wall, transversely striate. CHEMISTRY: thallus K+ yellow to red (red crystals), C+ yellow and KC+ orange reddish, P+ yellow; epithecium K-. Thiophaninic acid and norstictic acid.

ECOLOGY: Corticolous, on smooth bark (*Betula celtiberica, Crataegus monogyna, Quercus pyrenaica*). Scattered distribution, insufficiently known.

Diagnostic characters: apothecia verruciform, ascospores 2 per ascus and thallus K+ red. The presence of norstictic acid is common in saxicolous specimens of *Pertusaria* with xanthones, but it is found rarely in the corticolous specimens. Recently LUMBSCH *et al*. (1993) have described *P. huneckiana,* a saxicolous species from Balearic Islands. *P. luteola* is distinguished from *P. heterochroa* by the presence of norstictic acid in place of stictic acid, a distinction similar to that between the saxicolous species *P. huneckiana* (q.v.) and *P. rupicola.*

Specimens examined. **SPAIN**. **Andalucía**, Málaga, Antes del Puerto de Galis, *Crataegus monogyna,* 17.IV.1994, Gómez-Bolea & E. Jiménez, BCN 13120.- **Galicia**: Lugo, Palas del Rei, Castillo Pconre, *Betula celtiberica,* 12.I.1991, Etayo, Bahillo & López de Silanes, SANT 7545*.- Lugo, Carretera de Prades, *Betula celtiberica,* Herb. Etayo 5592*. Lugo, Villalba, A Charca, 20.III.92, Paz Bermúdez & López de Silanes, SANT 8841.

12. Pertusaria paramerae A. Crespo & Vězda, Anales Jard. Bot. Madrid, 41(2): 251-255 (1985).

Thallus thin, white-greyish or with a yellow-brown tinge, continuous or cracked and areolate, lacking soredia and isidia. Apothecia numerous, scattered or grouped, crateriform, irregular, not constricted at the base, 0.5-1.5 mm in diam., first punctiform, later irregularly open. Disc black, covered with white thick pruina. Margin concolorous with the thallus, prominent, cracked. Epithecium yellow greenish. Ascospores 1 per ascus, colourless or inside pinkish, 120-150 x 40-50 μm, with a double wall, 5-8 μm thick, with subtle transversal striations. CHEMISTRY: thallus K+ pale yellow, C-, KC+ yellow orange P-; epithecium K+ and N+ pink violet. Thiophaninic acid and planaic acid

ECOLOGY: Corticolous (*Buxus sempervirens, Juniperus communis, J. oxycedrus, J. phoenicea, J. thurifera, Pinus nigra* ssp. *salzmannii*) or rarely lignicolous, on *Juniperus* and *Pinus* wood, in sunny and unprotected conditions. Occurs in crustouse lichen communities with *Megaspora verrucosa, Lecanora horiza, Lecidella elaeochroma* and *Pertusaria albescens,* and with some foliaceous lichens such as *Physcia* or *Physconia.* On exposed calcareous edges, spurs and summits, emerging over the woods, in the suprameditterraneous bioclimatic stage. See discussion under *P. caesioalba.*

Specimens examined. **SPAIN**. **Castilla y León**: Soria, Judes, *Juniperus thurifera,* 24.V.1983, Crespo & V_zda, V_zda-Lich. Sel. Exs. 1979, (Isotypus), BCN 2037* (chrom. by M. Giralt), MAF 730* & MUB 1481*.- Soria, Judes, 24.V.1983, *J. thurifera,* Mayrhofer, GZU*.- **Catalunya**: Tarragona, Paüls, Montsagre de Paüls, 20.X.1990, *Pinus nigra* ssp. *salzmannii,* Herb. Boqueras d85.- Tarragona, Roquetes, Caro, 10.II.1990, *Pinus sylvestris,* Boqueras, BCN 13090.- Tarragona, Roquetes, font Mala, final del barranc del Regatxol, 4.VII.1987, *Juniperus communis,* Herb. Boqueras c65.- Tarragona, La Sénia, el Negrell, 1.XII.1984, *Buxus sempervirens,* Herb. Boqueras b95-b96, *Juniperus phoenicea* (wood and bark), Herb. Boqueras b98-b100.- Tarragona, La Sénia, Barranc de la Coscollosa, 23.IX.1990, *J. phoenicea,* Boqueras, BCN 13101.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *Buxus sempervirens,* Boqueras, BCN 13100, *Juniperus oxycedrus,* Herb. Boqueras d103, d104, d106, d179, *J. phoenicea* (wood), Herb. Boqueras d173, *J. phoenicea,* Boqueras, BCN 13099.- Tarragona, Horta de Sant Joan, riu d'Estrets, 10.II.1991, on wood, Herb. Boqueras d255.- Tarragona, Serra del Cardó, La Xàquera, *J. phoenicea,* M. Giralt, BCN 13112*.

13. Pertusaria pertusa (Weigel) Tuck., Enumer. North Amer. Lich. 56 (1845); *Sphaeria pertusa* Weigel, Observ. Bot. 46 (1772); *Lichen pertusus* L., Mant. Plant. 1:131 (1767), nom illegit.; = *P. colliculosa* Körb.; = *P. communis* DC.; = *P. communis* var. *gaditana* (Clem.) Colmeiro; = *P. communis* var. *plumbea* Harm.; = *P. communis* var. *polycarpa* Clem.; = *P. communis* var. *rupestris* DC.; = *P. communis* var. *variolosa* Schaer.; = *P. pertusa* var. *polycarpa* (Clem. ex Colmeiro) Zahlbr. em. Erichsen; = *P. pertusa* var. *rupestris* (DC.) Dalla Torre et Sarnth.; = *P. rupestris* (DC.) Schaer.

Thallus thick, greyish green or pale greyish, rarely with a white marginal zone, 1 mm thick, lacking soredia and isidia. Apothecia verruciform, numerous, constricted at the base and flattened, 1-3 mm in diam. Ostioles black, punctiform, 1-10 per verruca. Ascospores 2 per ascus, ascospores with double wall, rough, markedly transversally striated, 140-220 x 50-80 µm. CHEMISTRY: thallus K+ yellow, KC+ yellow to reddish, P+ orange or P-. Corticolous specimens: coronaton, stictic acid, constictic acid, hypostictic acid (±), hypoconstictic acid (±), cryptostictic acid (±). Saxicolous specimens: coronaton, stictic acid, constictic acid, norstictic acid (±).

ECOLOGY: Corticolous or saxicolous (the later frequently quoted as *P. rupestris*). Grows on rough or smooth bark (*Abies pinsapo, Acer opalus* ssp. *granatense, Acer* sp., *Betula celtiberica, Castanea sativa, Ceratonia siliqua, Corylus avellana, Fagus sylvatica, Hedera helix, Ilex aquifolium, Juniperus phoenicea, Pistacia terebinthus, Prunus dulcis, Quercus canariensis, Q. ilex, Q. ilex* ssp. *ballota, Q. pubescens, Q. pyrenaica, Q. robur, Q. suber, Sorbus aria, Ulmus glabra, U. minor*) but does not occur on *Pinus*. It is frequent in the evergreen oak forests and in the mountain region forest, in sunny and unprotected conditions, with parmelioid and thick crustaceous lichens such as *Pertusaria hymenea, P. albescens, Tephromela atra, Caloplaca ferruginea, C. alnetorum*. Rarely in shaded and humid habitats, mixed with the *Graphidion* species. Also on siliceous rocks. The saxicolous ecotype has been frequently quoted as *Pertusaria pertusa* var *rupestris*. In the supramediterranean belt it frequently forms heliophobous mountain communities, photophilous on steep (75°-100°) siliceous surfaces, mainly facing N, refered as *Pertusarietum rupestris* Egea et Llimona, 1987. Widespread across the Iberian Peninsula.

Specimens examined. **SPAIN**. **Andalucía**: Almería, Gérgal, Sierra de Filabres, Piedra del Sombrero, 22.IX.1979, Egea, MUB 485.- Almería, Bacares, Sierra de Filabres, Merendera, 3.X.1978, Egea, MUB 433.- Almería, Tabernas, Pico Alhamilla, 21.IX.1979, Egea, MUB 487, 8943 & 8940.- Almería, Uleila del Campo, Monteagudo, 2.IV.1979, Egea, MUB 435.- Almería, Sierra de los Filabres, Piedra del Sombrero, saxicolous, Sérusiaux 4261, Herb. M.- Cádiz, Jimena de la Frontera, *Quercus canariensis,* Sequeiros & Rowe, SEV-F 5814*.- Cádiz, Sierra Aljibe, Rowe, SEV-F 1771, 4278*.- Cádiz, Sierra Plata, Monte de la Silla del Papa, Rowe, SEV-F 4279.- Cádiz, Sierra Plata, Monte de la Silla del Papa, *Quercus suber,* Sequeiros & Rowe, SEV-F 5324*.- Cádiz, Tarifa, Sierra del Cabrito, *Q. suber,* 8.IV.1990, Egea & Alonso, MUB sn.- Cádiz, Tarifa, epiphytic, IV.1953, J. Poelt, Herb. M*.- Málaga, Estepona, Sierra Bermeja, Genalguacil, *Abies pinsapo,* Egea, MUB sn.- Málaga, Sierra de las Nieves, *A. pinsapo,* 28.I.1983, V.E. Martín, MAF 216.- **Asturias**: Cangas, *Quercus,* 13.VIII.1963, Schauer, Herb. M.- Covadonga, *Acer* and *Fagus,* 11.VIII.1962, Schauer, Herb. M.- Puerto Ventana, epiphytic, 1.IX.1980, equipo, MAF 3175.- Alto de el Palo, pizarra, 23.IV.1988, Terrón, LEB 644.- **Balears**: Mallorca, Bunyola, *Ceratonia siliqua,* ESS-Feige 7446.- Mallorca, Binifaldó, *Quercus ilex,* XI.1981, Herb. Fiol sn*.- Mallorca, Esporles, Mola de Planici, II.1983, *Juniperus phoenicea,* Herb. Fiol sn.- Mallorca, Valldemossa, font de S'Abernada, *Q. ilex,* IX.1983, Herb. Fiol sn.- Mallorca, Aljabia, *Q. ilex,* 1984, Herb. Fiol sn.- Mallorca, Coma de Narbona, *Q. ilex,* 1983, Herb. Fiol sn.- Mallorca, Sóller, Punta d'Ofre, IV.1964, Ch. & J. Poelt, Herb. M*.- Mallorca, Coll de Sóller, 16.V.1985, H. Mayrhofer, GZU.- Menorca, Cap Favartx, sax., ESS-Feige 12913.-

Cantabria, Luriezo, *Castanea sativa,* 7.IX.1990, Úbeda & Terrón, LEB 1569.- **Castilla-La Mancha**: Albacete, Riópar, Sierra del Calar del Mundo, Fuente de las Raigadas, 17.IX.1984, Egea & Moreno, MUB 6111, del 6113 al 6115.- Albacete, Riópar, Sierra del Calar del Mundo, lago de las Truchas, 18.IX.1984, Egea & Moreno, MUB 6116.- Albacete, Sierra del Relumbrar, Reolid, saxícola, 6.X.1978, Egea, MUB 434.- Toledo, Puente del Arzobispo, río Huso, 18.IV.1984, Buschardt, GZU*.- **Castilla y León**: Burgos, Santo Domingo, roble, 21.VIII. 1962, Schauer, Herb. M.- León, Hornija, *C. sativa,* 14.XII.1986, Terrón, LEB 1561 & LEB 2613.- León, Bárcena, *C. sativa,* 21.X.1988, Terrón, LEB 2196.- León, Matachana, *C. sativa,* 21.X.1988, Terrón, LEB 2209.- León, Congosto, *C. sativa,* 21.X.1988, Terrón, LEB 2193.- León, Sta M. del Sil, *Quercus pyrenaica,* 7.V.1984, Terrón, LEB 1535.- León, Villanueva de Valdueza, *C. sativa,* 20.XII.1986, Terrón, LEB 1545.- León, Paradaseca, *C. sativa,* 21.XII.1986, Terrón, LEB 1554.- León, Mascariel, limonita, 23.VII.1989, Terrón, LEB 311.- León, La Peña, Serna, cuarcita, 24.VI.1989, Terrón, LEB 315.- León, Mascariel, cuarcita, 23.VII.1989, Terrón, LEB 313.- León, La Vega grande, pizarra, 20.VII.1987, Terrón, LEB 2425.- León, La Peña, Serna, cuarcita, 24.VI.1989, Terrón, LEB 310.- Salamanca, Fuentes de Béjar, 16.XI.1980, *Quercus ilex* ssp. *ballota,* Marcos, SALAF 538*.- Salamanca, Peña de Francia, 21.IX.1980, *Q. pyrenaica,* Marcos, SALAF 537.- Salamanca, Linares de Riofrio, 19.VI.1983, *Hedera helix,* Marcos, SALAF 2131.- Salamanca, Miranda del Castañar, 27.VII.1980, *C. sativa,* Marcos, SALAF 536.- Salamanca, Sequeros, 19.III.1981, *Q. pyrenaica,* Marcos, SALAF 541.- Soria, Barranco de Castilla, *Fagus sylvatica,* 4.IX.1984, Gómez-Bolea, BCN 3531.- Zamora, Vega de Tera, arenisca, 16.VII.1994, Terrón, LEB 1796.- **Catalunya**: Barcelona, Montseny, Frey-HBG 4110.- Barcelona, Montserrat, *Q. ilex,* Frey, HBG.- Barcelona, Coll Formic, 28.V.1983, *Quercus pubescens,* Hafellner, GZU.- Barcelona, Sant Llorenç del Munt, *Q. ilex,* Boqueras, BCN 13143.- Girona, Montseny a Blanes, Frey-HBG, 4111* (tipo de *P. pertusa* var *deplanata* Erichsen, chrom. by Hanko).- Tarragona, Prades, Frey-HBG 4120 (sub *P. rupicola*).- Tarragona, Monestir de Poblet a Vilanova de Prades, 23.V.1983, silicícola, GZU*.- Tarragona, Prades, Vimbodí, Castellfollit, *C. sativa,* Hladun, BCN 3783*.- Tarragona, Paüls, Montsagre de Paüls, 20.X.1990, *Ilex aquifolium,* Herb. Boqueras d183.- Tarragona, La Sénia, Barranc del Racó de l'Avellanar, 1.XI.1990, *Acer opalus* ssp. *granatense,* Herb. Boqueras d194x.- Tarragona, La Sénia, Barranc dels Cirers, 10.II.1991, *Q. ilex,* Boqueras, BCN 13103 & 13104.- Tarragona, La Sénia, Barranc del Retaule, 6.VII.1988, *A. opalus* ssp. *granatense,* Herb. Boqueras a2, a3, *F. sylvatica,* Herb. Boqueras a176, a181, *Sorbus aria,* Herb. Boqueras a177.- Tarragona, La Sénia, Mola dels Conills, 14.II.1987, *F. sylvatica,* Herb. Boqueras 222.- Tarragona, La Sénia, el Negrell, 1.XII.1984, *Corylus avellana,* Herb. Boqueras d241.- Tarragona, La Sénia, Font del Teix, 23.IX.1990, *A. opalus* ssp. *granatense,* Herb. Boqueras d22.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *Juniperus phoenicea* wood, Herb. Boqueras d151, d173, *J. phoenicea,* Boqueras, BCN 13105, *Pistacia terebinthus,* Herb. Boqueras d197, *Q. ilex,* Boqueras, BCN 13106, *Ulmus glabra,* Herb. Boqueras d146, *Ulmus minor,* Herb. Boqueras d160.- **Euskadi**: Araba, Landa, *Quercus robur,* 1.VIII.1983, B. Aguirre, MAF 703*.- Guipuzcoa, Sierra de Aralar, *F. sylvatica,* 1.V.1984, B. Aguirre, MAF 702.- Guipuzcoa, Tolosa, *Quercus,* 11.IV.1953, Doppelbaur, Herb. M*.- **Galicia**: A Coruña, Mañón, Grañas, *Q. robur,* 20.II.1988, A. Garci, SANT 6527.- Lugo, Villalba, *Quercus,* 16.VIII.1962, Schauer, Herb. M.- Lugo, Ancares, 20.VI.1992, Paz Bermúdez & López de Silanes, SANT 8844.- Lugo, Palas del Rei, Castillo Pconre, *Betula celtiberica,* 12.I.1991, Etayo, Bahillo & López de Silanes, SANT 7546.- Ourense, Invernadeiro, *I. aquifolium,* 21.VI.1973, Crespo & Castroviejo, MAF 1794.- Ourense, Sierra del Invernadeiro, Barranco de Guasenza, *I. aquifolium,* 12.VII.1988, Carballal, SANT 4480.- Ourense, Poba de Trives, *Q. pyrenaica,* Boqueras, BCN 13142.- Pontevedra, La Guardia a Vigo, granito, 8.VIII.1963, Schauer, Herb. M*. - **La Rioja**: Logroño, Fuerte de Velate, Feuerer, HBG.- Ezcaray, *F. sylvatica,* 21.VIII.1962, Schauer, Herb. M.- **Murcia**, Sierra de Carrascoy, Rambla de Roy, *Q. ilex* ssp. *ballota,* 4.XII.1983, MUB sn.- **Navarra**: Rincón de Belagua, *F. sylvatica,* 1973, Llimona, BCN 2502* & JACA 1384*.- Roncesvalles, *F. sylvatica,* 31.VIII.1963, Schauer, Herb. M.

PORTUGAL. **Algarve**, Portimas, *Prunus dulcis,* P.v.d. Boom 923*.- **Beira Alta**: Caramulo, *Q. robur,* Herb. M. P. Jones.- Trancoso, saxícola, 1.IX.1962, Tavares, Lich. Lusit. Exs. 164, Herb. M* & GZU.- Seia, Serra da Estrela, 3.VIII.1963, Schauer, Herb. M*.- **Beira Baixa**, Tejo, 22.IX.1983, Brunner, GZU.- **Minho**, Carreco Viana, 8.VIII.1963, Schauer, Herb. M*.- **Trás-os-Montes**: Bragança, III.1923, Sampaio, Lich. Portugal 155, Herb. M*.- N de Carrajoso, NW de Bragança, *C. sativa,* Herb. M. P. Jones.- **?**, Póvoa das Quartas, *C. sativa,* 26.IX.1964, Schauer, Herb. M*.

14. Pertusaria plombii de Lesd., Bull. Soc. Bot. France, 95: 197 (1948).

Thallus thin and smooth, pale grey to yellow-green, somewhat cracked, lacking soredia and isidia. Apothecia verruciform, 0.8-1 mm diam., dispersed, more or less round, flattened-hemispheric. Ostiole punctiform and pale, 1-2 per verruca. Ascospores 8 per ascus, uniseriate or rarely biseriate, 30-60 x 20-32 μm, double and smooth wall, 3 μm thick. CHEMISTRY: Thallus K+ yellow, C+, KC+ and P+ orange or P-; epithecium K- and C-. Thiophaninic acid.

ECOLOGY: Corticolous, on smooth bark (*Acacia, Alnus glutinosa, Corylus avellana, Pinus halepensis, Quercus rubra*). Disjunct distribution in the Iberian Peninsula.

Diagnostic characters: thin, yellowish thallus, almost flattened fertile verrucae, 8-sporad asci and a C+ orange reaction due to the presence of thiophaninic acid. The morphologicaly related species *P. alpina* contains coronaton and, in contrast to *P. plombii,* gives a C-ve reaction.

Specimens examined. **SPAIN**. **Andalucía**, Cádiz, Jerez de la Frontera, S. Henás, Herb. Etayo 5062.- **Catalunya**, Tarragona, Masarbonés, *Pinus halepensis,* 23.X.1987, M. Giralt, BCN 4143*. - **Navarra**, Ibardín, *Quercus rubra,* Herb. Etayo 4308*.- **Euskadi**, Guipuzcoa, Eñerozu, *Alnus glutinosa,* Herb. Etayo 6056.- **Galicia**: A Coruña, Valle del Eume, Convento de Caaveiro, *Corylus avellana,* Boqueras, BCN 13141*.- Ourense, Camino de Bodes, *A. glutinosa,* Herb. Etayo sn*.- Pontevedra, Vigo, Quiñones de León, *Acacia,* VIII.1984, SANT 2020.

15. Pertusaria pluripuncta Nyl., Flora 66: 532 (1883); = *P. gallica* de Lesd, Ann. Soc. Hist. Nat. Toulon 10: 103 (1924); incl.: *P. gallica* var. *dealbata* Llimona, Butl. Soc. Catalana Biol. 3-4:146 (1980).

Thallus irregular, thick, cracked-areolate, yellow-greyish or green-greyish, generally clearly delimited by a black hypothalline line, in contact with other lichens and generally narrowly zonated; the areoles 0.5-2 mm in diam., angulose, conspicously convex, surface smooth or very irregular. Sometimes each areola has 1-(4) pycnidia, but it is always devoid of soredia and isidia. Rarely fertile. Apothecia small, immersed. Disc black. Ascospores 2 per ascus, colourless or greyish, 80-140 x 30-60 μm, wall double, 10-15 μm thickness, transversely striate. CHEMISTRY: thallus K+ yellow, KC+ and C+ orange, P+ orange; epithecium K+ violet. Thiophaninic acid, stictic acid, norstictic acid (±), cryptostictic acid (±), constictic acid (±), hypostictic acid (±), menegazziaic acid (±).

ECOLOGY: Taxon saxicolous and silicicolous, photophilous, heliophobous, moderately nitrophilous, limited to areas with mild winters.

P. pluripuncta is distinguished from the chemically similar *P. rupicola* by the less developed, yellower thallus, and the number of ascospores per ascus.

Specimens examined. **SPAIN**. **Andalucía**: Almería, Rodalquilar, sierra de Gata, Follmann Lich. Exs. Cassel. 370, Herb. BCN 1794, GZU; 6.VI.1979, Buschardt, GZU*.- Almería, San José, El Borronal, lava ácida, III.1975, Llimona, MAF 656.- Almería, Cabo de Gata, Vela Blanca, 13.IX.1982, Egea, MUB 1256.- Almería, Cabo de Gata, 22.IX.1980, Hafellner*.- Almería, Carboneras, Punta los Muertos, 18.III.1990, Egea & Alonso, MUB 21109.- Cádiz, El Picacho, Rowe, SEV-F 1808, 1877*, 3230*.- Cádiz, Río Aljibe, Rowe, SEV-F 1939.- Cádiz, Sierra Plata, Monte de la Silla del Papa, Rowe, SEV-F 1858, 1832, 1848, 1746.- Cádiz, Montera del Torero, los Barrios, Rowe, SEV-F 1802.- Cádiz, Tarifa, Sierra de la Plata, Monte de la Silla del Papa, arenisca ácida, 6.IX.1985, Rowe, MAF 2952.- Cádiz, Gibraltar, sandstone, 10.6.1954, Werner, BC.- **Asturias**, Oviedo, Cabo de Peñas, 3.IX.1980, Herb. Hafellner.- **Balears**, Menorca, Binimel·là, ESS-Feige 10663*, 11251*.- **Canarias**: Gran

Canaria, Tarifa, 1.IV.1901, Bornmüller, WU* sub *P. subcicatricosa*.- Gran Canaria, Isleta, 29.III.1901, Bornmüller, WU* sub *P. subcicatricosa*.- **Galicia**, A Coruña, A Capelada, SANT 9163*.- **Murcia**: Aguilas, Cabo Cope, Egea, MUB 425.- Cabo de Palos, isla Perdiguera, andesitas, 4.III.1984, Egea, V_zda-Lich. Sel. Exs. 1998, Herb. BCN 2012.- Cabo de Palos, Carmolí, 12.IV.1973, Llimona, MUB 1661.- Cabo de Palos, Isla Mayor, 25.III.1975, Llimona, MUB 1660, 422, 424 & 8913.- Cabo de Palos, Isla Grossa, 3.II.1978, Llimona & Egea, MUB 1662.- Cartagena, Cabezo Negro de Tallante, 13.IV.1976, Egea, MUB 8920.- La Manga del Mar Menor, Egea & Hafellner, Herb. Hafellner* & GZU.- **País Valencià**, Castelló, illa Columbret gran, laves alterades, Llimona, 3.5.1973, BCN sn*. **PORTUGAL**. **Algarve**, Praia de Castelejo, Vila de Bispo, Herb. M. P. Jones.- **Estremadura**, Mafra, Ericeira Carvieiro, Playa San Juliao, 20.II.1987, Egea, MUB 21110.- **Lusitania**, Nylander, H-NYL 23455* (chrom. by Hanko).

16. Pertusaria praelutescens Werner, Bull. Soc. Mycol. France 86-4: 818 (1970).

Thallus cracked-areolate, slightly verrucose, yellow-greenish. Isidia concolorous with the thallus, globulous and simple, 0.05-0.15 mm in diam., widespread across the thallus, rarely with cylindrical isidia, 0.3 mm height. Apothecia not seen in the material from the Iberian Peninsula. CHEMISTRY: thallus K+ red, C+ orange, KC+ intense orange and P+ yellow. Thiophaninic acid and norstictic acid.

ECOLOGY: Corticolous. Rifano-Baetic distribution.

The type collection of *P. praelutescens* is from Morocco and was reported to be fertile (Werner, *loc.cit.* and BOQUERAS, 1997). However, the peninsular material, which has the same chemistry, is sterile. The morphologically similar *P. flavida* is usually devoid of apothecia but is distinguished from *P. praelutescens* by the chemistry, as shown in Table 1. Both species occur sympatrically in Mojón de la Viuda (Andalucía).

Table 1. *Pertusaria praelutescens* and *P. flavida.*

	P. praelutescens	*P. flavida*
Apothecia	superficial, flexuose disc open	immersed disc punctiform
Ascospores	4-5 (8) per ascus 52-68 x 25-35 μm	(4) 8 per ascus 60-100 x 25-40 μm
Chemistry	thiophaninic & norstictic acids	thiophaninic & stictic acids or thiophaninic & 2'-*O*-methyl- perlatolic acids

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Carretera de Ubrique a Puerto de Galis, Mojón de la Viuda, 17.IV.1994, Gómez-Bolea & E. Jiménez, *Quercus suber*, BCN 13068*.- Cádiz, Villaluenga del Rosario, *Q. suber*, Sequeiros & Rowe, SEV-F 5312*.- Málaga, Sierra de las Nieves, Camino del Cortijo de los Quejigales, 16.IV.1994, Gómez-Bolea & E. Jiménez, *Quercus ilex*, BCN 13223.

17. Pertusaria pustulata (Ach.) Duby, Bot. Gall. 2(2): 673 (1830); *Porina pustulata* Ach., Lich. Univ.: 309 (1810); = *Pertusaria limona* Zahlbr.; = *P. pustulata* f. *pustulata*; = *P. pustulata* var. *melaleuca* Nyl.; = *P. exalbescens* Nyl.

Thallus thin and cracked, grey-greenish, lacking soredia and isidia. Apothecia verruciform, scattered to grouped, flattened, constricted or not at the base, 1-3 mm in diam. Ostiole dark brown or black, punctiform or somewhat open, 1-8 per verruca. Epithecium blackish. Ascospores 2 per ascus, 50-100 x 30-35 μm, double wall, rough. CHEMISTRY: thallus

K+ pale yellow and KC+ yellow or orange, C+ yellow, P+ yellow or P+ orange; epithecium K+ red-violet. 2-chloro-6-O-methylnorlichexantone, stictic acid, norstictic acid (±), cryptostictic acid (±), constictic acid (±), hypostictic acid (±), hypoconstictic (±), menegazziaic acid (±).

ECOLOGY: Corticolous (*Acacia, Alnus glutinosa, Castanea sativa, Nerium oleander, Quercus canariensis, Q. robur, Q. rubra, Q. suber*), in humid and shaded habitats. Widespread in all parts of the Iberian Peninsula.

Easily identified by the black ostioles, the K+ red-violet reaction of the epithecium and asci with 2 ascospores. This is the only species of *Pertusaria* from Iberian Peninsula containing 2-chloro-6-*O*-methylnorlichexantone. The species sometimes resembles *P. heterochroa* but the two species are distinguished by the K+ red-violet reaction in *P. pustulata*. Rarely specimens of *P. heterochroa* may give a K+ red-violet reaction; in these case, chemical analysis is required to identify *P. pustulata.*

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Jerez de la Frontera, Canto del Caballo, 18.IV.1994, *Nerium oleander,* Gómez-Bolea & E. Jiménez, BCN 13110.- Cádiz, Facinas, S. de Salaviciosa, *Quercus suber,* Sequeiros & Rowe, SEV-F 5400*.- Cádiz, Sierra Plata, Monte de la Silla del Papa, *Q. suber,* Sequeiros & Rowe, SEV-F 5403*.- Cádiz, Castellar de la Frontera, *Q. suber,* Sequeiros & Rowe, SEV-F 5869*.- Málaga, Canutillo, parque de los Alcornocales, *Quercus canariensis,* Gómez-Bolea & E. Jiménez, BCN 13108*.- **Catalunya**: Girona, Begur, *Q. suber,* 21.VII.1984, Boqueras, BCN 3318*.- Girona, Cassà de la Selva, *Q. suber,* 21.VII.1984, Boqueras, BCN 3317.- **Euskadi**, Guipuzcoa, Itsasondo, *Alnus glutinosa,* 25.III.1984, B. Aguirre, MAF 1784*.- **Galicia**: A Coruña, Iglexefeita, *Quercus robur,* 22.II.1988, A. Garci, SANT 6610*.- A Coruña, Pontedeume, Caaveiro, *Castanea sativa,* 4.VI.1986, Carballal & López de Silanes, SANT 2591*.- A Coruña, Costa W, 16.VIII.1962, Th. Schauer, Herb. M*.- A Coruña, Lage, Costa W, 16.VIII.1962, Th. Schauer, Herb. M.- Pontevedra, Vigo, Quiñones de León, *Acacia,* VIII.1984, SANT 1074.- Pontevedra, Río Imuno, 8.VIII.1963, Th. Schauer, Herb. M*.- **Navarra**, Ibardín, *Quercus rubra,* Herb. Etayo sn*.
PORTUGAL. **Beira Litoral**: Oliveira do Hospital, *Alnus,* P.v.d. Boom 14285*.- Fatima, 4.VIII.1963, Th. Schauer, Herb. M*.- **Beira Alta?**, Bàrro Menyharth, WU (chrom. by Hanko).- **Douro**, Porto, estrada da circunvalaçao, III.1923, Sampaio, Lich. Portugal n° 156, Herb. M*.

18. Pertusaria rupicola (Fr.) Harm., Bull. Soc. Sci. Nancy Sér. 2: 32 (1897); *Pertusaria wulfenii* var. *rupicola* Fr., Lich. Europ. Reform.: 424 (1831); = *P. rupicola* var. *bispora* Werner

Thallus thick, cracked-areolate and verrucose to cerebriform, grey-greenish or yellow-green, lacking soredia and isidia. Apothecia in fertile, lecanorine verrucae, rounded, 1-3 mm in diam., usually numerous and tight. Margin thick, smooth and the same colour of the thallus. The hymenium often has sterile areas. Ostioles matt black to yellow pale brown, initially punctiform, later open, 1.5 mm in diam. Ascospores (6)-8 per ascus, double and smooth wall, 70-100 x 30-50 μm. CHEMISTRY: thallus K+ yellow, C+ and KC+ orange and P+ red orange; epithecium K+ red violet and C+ red violet; margin of the apothecia rarely K+ red. Thiophaninic acid, stictic acid, norstictic acid, cryptostictic acid, menegazziaic acid (±), atranorin (±).

ECOLOGY: Taxon saxicolous and silicicolous, photophilous but heliophobous, usually on steep surfaces facing to the North. Mediterranean distribution. See discussion under *P. huneckiana.*

Specimens examined. **SPAIN**. **Catalunya**: Barcelona, Montseny, 28.V.1983, Egea, MUB 8944*.- Girona, del Montseny a Blanes, HBG* (chrom. by Hanko, sub *P. wulfenii* var. *rupicola*).- Girona, Figueres, IV.1953, Poelt (M*).- Girona, Port de la Selva, Cala Tamariua, 12.VIII.1969, Llimona, BCN 158*.- Tarragona, Serra de Prades, Ermita de l'Abellera, gres,

13.VII.1997, Boqueras sn*.- Tarragona, Serra de Prades, La Baltasana, 23.V.1983, Egea, MUB 1454*; Gómez-Bolea & Hladun, BCN 2295* & BCN 2305*.- Tarragona, Mola dels quatre termes, gres, Boqueras, BCN 13226*.- Tarragona, Serra de Prades, Frey n° 4120, HBG*.
FRANCE, La Massane, H-NYL. 23130*.

19. **Pertusaria werneriana** Boqueras sp. nov.

Thallus griseo-albidus vel subviridi-flavus, fissuratus-areolatus, ad marginem laevis, isidiis et sorediis destitutus. Apothecia verruciformia, numerosa, in verrucas 2na, thallo concoloribus, plano-subhemisphaerica, basibus non constrictis, 1-2 mm in diam.; ostiola punctiformia, hyalina; sporae 8nae, uniseriatae, ellipsoideae, laeves, 45-58 µm, longae, 25-30 µm latae. Corticola. Thallus acidum thiophaninicum, acidum 2'-O-methylperlatolicum et acidum confluentic continens.
TIPUS: Hispania, Andalucía, Cádiz, Jerez de la Frontera, Canto del Caballo, 18.IV.1994, *Nerium oleander*, Gómez-Bolea & E. Jiménez, BCN 13119*.

Thallus cracked and areolate at the centre and continuous at the margin, somewhat verrucose, pale grey-greenish or yellow-green, lacking soredia and isidia. Apothecia verruciform, dispersed or grouped, 1-2 mm in diam., not constricted at the base. Ostiole punctiform, pale, 1-2 per verruca. Ascospores 8 per ascus, uniseriate, ellipsoid, colourless, 45-58 x 25-30 µm, double and smooth wall. CHEMISTRY: thallus K+ pale yellow, C-, KC-, P-. Coronaton, 2´-O-methylperlatolic acid and confluentic acid.

ECOLOGY: Corticolous (*Olea europaea, Opuntia* sp., *Phillyrea latifolia, Pistacia lentiscus, Quercus ilex, Q. suber, Tilia cordata*). Found on young branches, in warm and sunny habitats, with species characteristic from the association *Lecanoro hybocarpae-Caloplacetum pollinii* (BOQUERAS, 2000). Mediterranean distribution.

Diagnostic characters: verruciform apothecia, asci with 8 ascospores and its chemistry.
This species is morphologicaly similar to *P. alpina* Ahles (q.v.), *P. carmelii* Reichter & Galun (from Israel, GALUN & REICHERT, 1965) and *P. gibberosa* Müll. Arg. (from Australia, ARCHER, 1997) but the 3 species may be differentiated by chemistry and the number of ascospores per ascus, Table 2.

Table 2. *Pertusaria* species containing coronaton.

	P. werneriana	*P. gibberosa*	*P. carmelii*	*P. alpina*	*P. leucostoma*	*P. pertusa*
2´-*O*-methylperlatolic acid	–	–				
confluentic acid	–		–			
stictic acid				–	–	–
Ascospores per ascus:	8	8	2	8	3-4(6)	2

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Jerez de la Frontera, *Quercus suber*, Sequeiros & Rowe, SEV-F 5852*.- Cádiz, Gibraltar, 10.VI.1934, *Olea europaea*, Werner, BC*.-**Balears**: Mallorca, Campos, Ses Sitjoles Seques, *Opuntia* sp., II.1987, Herb. Fiol 380*.- Mallorca, Marratxí, *Quercus ilex*, 1984, Font, Herb. Fiol sn*.- Menorca, Ciutadella,

prop de Son Planas, 5.VII.1993, Boqueras, *Q. ilex,* BCN 13117*, *O. europaea,* BCN 13118*.- **Catalunya**: Tarragona, Sant Carles de la Ràpita, barranc del Solito, 18.V.1987 & 25.VII.1986, *Pistacia lentiscus,* Boqueras, BCN 13114*.- Tarragona, Barranc de les Aurenelles, *Phillyrea latifolia,* herb. M. Giralt 870*.- Tarragona, Barranc de Montalt, *Q. ilex,* herb. M. Giralt 1135*.- Tarragona, La Mola de Coll de Jou, *Q. ilex,* M. Giralt, BCN 13115*.- **País Valencià**, Castelló, Pobla de Benifassà, barranc de l' Avellanar, 1100 m, 21.X.1990, *Q. ilex,* Boqueras, BCN 13121, *Tilia cordata,* Boqueras, BCN 13122.- **S España**: Sierra Llana, *Pistacia,* 17.III.1978, Seaward, MAF 3136.
PORTUGAL. **Beira Alta?**, Bàrro 1890, Menyharth, WU*.
FRANCE: **Corcega**, Bonifacio, al borde de la ruta de Porto-Vecchio, IV.1968, *O. europaea,* R. Deschatres, BC*.

II. Species lacking chloroxanthones

20. Pertusaria coccodes (Ach.) Nyl. Mém. Soc. Sci. Nat. Cherbourg, 5: 116 (1857); *Lichen coccodes* Ach., Lich. Suec. Prodr.: 10 (1799); = *P. coccodes* (Ach.) Nyl. var. *petraea* Erichsen.

Thallus verrucose and cracked, grey-yellowish or brown-yellowish, generally delimited by a black or reddish hypothalline line. Isidia often dense, globulous to cylindrical, not constricted at the base, simple, sometimes branched, with dark brownish apices, 0.2-0.3 mm long and 0.1 mm in diam. Apothecia not seen. CHEMISTRY: thallus K+ red, C- and P+ orange. Norstictic acid and connorstictic acid. Some have atranorin.

ECOLOGY: Corticolous (*Acer opalus* ssp. *granatense, Betula, Buxus sempervirens, Ceratonia siliqua, Corylus avellana, Fagus sylvatica, Juniperus phoenicea, Olea, Pinus nigra* ssp. *salzmannii, Pinus sylvestris, Populus nigra, Quercus ilex, Q. ilex* ssp. *ballota, Q. petraea, Q. pyrenaica, Q. robur, Q. suber, Ulmus minor*). Occurs in open areas in forests, on a wide variety of trees. Some specimens with broken isidia appear sorediate and resemble *Phlyctis agelaea.*

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Sierra Plata, Monte de la Silla del Papa, *Quercus suber,* Sequeiros & Rowe, SEV-F 5403.- Cádiz, Alcalá de los Gazules, epífita, Sequeiros & Rowe, SEV-F 5402.- **Castilla y La Mancha**: Albacete, Riópar, Sierra del Calar del Mundo, Raigadas, *Corylus avellana,* Egea & Moreno, MUB 6102*.- Albacete, Riópar, Sierra del Calar del Mundo, Arroyo de la Celada, *Quercus ilex* ssp. *ballota,* Egea & Moreno, 6103*.- **Castilla y León**: León, Puerto del Pando, *Quercus petraea,* Herb. Etayo 5672.- Palencia, Velilla del Río, *Fagus sylvatica,* Herb. Etayo 5672.- Salamanca, Peña de Francia, 21.IX.1980, *Quercus pyrenaica,* Marcos, SALAF 489.- Salamanca, Béjar, 19.III.1981, *Populus nigra,* Marcos, SALAF 903.- Salamanca, La Alberca, 6.III.1983, *Q. pyrenaica,* Marcos, SALAF 2121.- **Catalunya**: Girona, Les Gavarres, *Q. suber,* Llimona, BCN 3954.- Lleida, Vall d'Aran, Artiga de Lin, *F. sylvatica,* Gómez-Bolea, BCN 3111.- Tarragona, Roquetes, Caro, 10.II.1990, *Pinus sylvestris,* Herb. Boqueras b60, b61.- Tarragona, La Sénia, Barranc del Racó de l'Avellanar, 1.XI.1990, *Acer opalus ssp. granatense,* Herb. Boqueras d194x.- Tarragona, La Sénia, Barranc dels Cirers, 10.II.1991, *Quercus ilex,* Herb. Boqueras 262.- Tarragona, La Sénia, Mola dels Conills, 14.II.1987, *F. sylvatica,* Herb. Boqueras 227.- Tarragona, La Sénia, el Negrell, 1.XII.1984, *P. sylvestris,* Herb. Boqueras a211.- Tarragona, La Sénia, Rafalgarí, 23.IX.1990, *Pinus nigra* ssp. *salzmannii,* Boqueras, BCN 13065.- Tarragona, La Sénia, Font del Teix, 23.IX.1990, *A. opalus ssp. granatense,* Boqueras, BCN 13064, *Juniperus phoenicea,* Herb. Boqueras d31, *P. sylvestris* wood, Herb. Boqueras d28.- Tarragona, Arnes, Barranc del Grevolar, 20.X.1990, *A. opalus ssp. granatense,* Herb. Boqueras d204, d186x, *Buxus sempervirens,* Herb. Boqueras d162, *Juniperus phoenicea* wood, Herb. Boqueras d190, *Q. ilex,* Boqueras, BCN 13066, *Ulmus minor,* Herb. Boqueras d160.- Tarragona, Horta de Sant Joan, barranc de les Closetes, 10.II.1991, *Q. ilex,* Herb. Boqueras d317.- **País Valencia**, Castelló, Pobla de Benifassà, boscos al sud del convent de Benifassà, 700 m, 30.V.1991, *Q. ilex,* Herb. Boqueras c126.- **Euskadi**, Araba, Ullibarri, Ollera, Portucho de Oquina, *Q. pyrenaica,* Etayo, MAF 1349.- **Extremadura**, Badajoz, Mérida, 14.IV.1979, Buschardt, GZU.- **Navarra**: Punta Urrizate, *Quercus robur,* Herb. Etayo 2941.- Larra, Valle del Roncal, Llimona, JACA 1360*.-

PORTUGAL. **Alentejo**, Pinheirinho do Cima, Ponte de Sor, *Olea*, Herb. M. P. Jones.- **Algarve**: Monchique, *Q. suber*, P.v.d. Boom 852.- Portimao, Silves, *Ceratonia siliqua*, P.v.d. Boom 14725.- **Minho**: NE Braga, Geres, *Betula*, P.v.d. Boom 6440; *Quercus*, P.v.d. Boom 6434.- E. de Monçao, *Q. robur*, Herb. M. P. Jones.

21. Pertusaria pseudocorallina (Lilj.) Arnold, Verh. K.K. Zool.-Bot. Ges. Wien, 37: 84 (1887); *Lichen pseudocorallinus* Lilj. Utkast Svensk Flora, 1 ed: 328 (1792); = *P. pseudocorallina* var. *concreta* (Nyl.) Samp.; = *P. concreta* Nyl.; = *P. westringii* (Ach.) Leight.; = *P. microstictica* (Sm.) Erichsen

Thallus thick, surface flattened or somewhat verrucose, cracked-areolate, pale grey-brownish. Isidia globulous to cylindrical, constricted at the base, simple or branched, with dark brownish apices dispersed or grouped in masses, scattered to crowded, 0.2-0.4 mm long and 0.2-0.5 mm in diam. Apothecia not seen. CHEMISTRY: thallus K+ red, P+ yellow, C- and KC-. Norstictic and connorstictic acids.

ECOLOGY: Saxicolous and silicicolous taxon. Photophilous, heliophobous, weakly nitrophilous, on steep siliceous surfaces, mainly facing N, in meso and supramediterranean belts, sometimes reaching the Central European montane belt. Widespread across the Iberian Peninsula.

Specimens examined. **SPAIN**. **Andalucía**: Cádiz, Sierra Plata, Monte de la Silla del Papa, Rowe, SEV-F 1858, SEV-F 1881*.- Cádiz, Sierra Plata, Rowe, MAF 2955 & BCN 1839.- **Catalunya**: Barcelona, Montseny, Fondal de Vallfornés, granit, I. Pereira, BCN 5461.- Barcelona, Pla de la Lliga Moltons, Hladun, 19.VII.1979, BCN 2691.- Barcelona, Collserola, esquists, Llimona, BCN 13107.- Girona, Tossa, Frey-HBG 4196.- Girona, Sant Pere de Rodes, Llimona, BCN 159* (chrom. M. Barbero).- Tarragona, Prades, La Baltasana, Hladun, BCN 2294.- Tarragona, entre el Monestir de Poblet i Vilanova de Prades, 23.V.1983, leg. Hafellner, GZU*.- Tarragona, Monestir de Poblet, Poelt, silicícola, GZU.- **Comunidad de Madrid**, Sierra de Guadarrama, Puerto de los Cobos, Hafellner, GZU-Haf. 10901.- **Galicia**: A Coruña, Cabo Finisterre, Buschardt-15165, GZU*.- A Coruña, Santiago de Compostela, Monte Pedroso, 31.X.89, Sánchez-Biezma, SANT 7625.- A Coruña, Pontedeume, Caaveiro, roca, 14.VI.1986, Estevez & López de Silanes, SANT 2724.- **Castilla y La Mancha**, Albacete, Alcaraz, Sierra del Relumbrar, saxícola, 7.X.1978, Egea, MUB 436.- **Castilla y León**, León, Cerro Peral, pizarra, 24.VI.1989, Terrón, LEB 307.

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REFERENCES

ARCHER, A.W. (1993) A chemical and morphological arrangement of the lichen of genus *Pertusaria*. *Bibl. Lichenol.* **53**: 1-17.

ARCHER, A.W. (1995) A chemical and morphological arrangement of the lichen of genus *Pertusaria*: additional data and corrections. *Mycotaxon* **55**: 385-389.

ARCHER, A.W. (1997) The lichen genus *Pertusaria* in Australia. *Bibl. Lichenol.* **69**: 1-249.

BOQUERAS, M. (1997) Els gèneres *Ochrolechia* i *Pertusaria* a l'herbari Werner. *Acta Bot. Barcinon.*, **44**:17-28.

BOQUERAS, M. (2000) *Liquens epífits i fongs liquenícoles del sud de Catalunya*. Institut d'Estudis Catalans. Archius de les seccions de Ciències, CXXVII: 1-556 pp.

CARBALLAL, R., BRAVO, I. & LÓPEZ DE SILANES, M.E. (1983) Novedades para la flora liquénica gallega. *Lazaroa* **5**: 277-281.

DIBBEN, M. J. (1980) *The chemosystematics of the genus* Pertusaria *in North America North of Mexico*. Milwaukee Publications in Biology and Geology **5**: 1-162.

ELIX J.A. & ERNST-RUSSELL, K.D. (1993) *A catalogue of standarized thin-layer chromatographic data and biosynthetic relationships of lichen substances* (2nd. Edition). Australian National University, Canberra.

ERICHSEN, C.F.E. (1936) *Pertusariaceae*. In L. Rabenhorst, Kryptogamen-flora von Deutschland. Österrich und der Schweitz. Ed.2, bd. 9, **5**(1): 319-702. Leipzig.

GALUN, M.& REICHERT, I. (1965) Lichens of Mt. Carmel. First Contribution. *Israel J. Bot.* **14**: 5-14.

HANKO, B. (1983) Die chemotypen Flechtengattung *Pertusaria* in Europa. *Bibl. Lichenol.* **19**: 1-297.

KLEMENT, O. (1965) Flechtenflora und Flechtenvegetation der Pityusen. *Nova Hedwigia* **9**: 1-4.

LUMBSCH, H.T., FEIGE, G.B. & SCHMITZ, K.E. (1993) *Pertusaria huneckiana,* a new Mediterranean lichen, with notes on some saxicolous *Pertusaria* species containing chloroxanthones. *Bibl. Lichenol.* **53**: 173-178.

LUMBSCH, H.T & SCHMITT, I. (2001) Molecular data suggest that the lichen genus *Pertusaria* is not monophyletic. *Lichenologist* **55** (2): 161-170.

LLIMONA, X. & HLADUN, N. (2001) Checklist of the lichens and lichenicolous fungi of the Iberian Peninsula and Balearic Islands. *Bocconea* **14**: 581pp.

PURVIS, O.W., COPPINS, B.J., HAWKSWORTH, D.L., JAMES, P.W. & MOORE, D.M. (1992) *The lichen flora of Great Britain and Ireland.* Natural History Museum, London. 710pp.

SCHREINER, E. & HAFELLNER, J. (1992) Sorediöse, corticole krustenflechten im Ostalpenraum .I. Die Flechtentoffe und die gesicherte Verbreitung der besser bekannden Arten. *Bibl. Lichenol.* **45**:1-291.

SCHMITT, I. (2002) Molecular phylogeny of the Pertusariales (lichenised Ascomycotina). Ph. D. Thesis:1-333, University of Essen, April 2002.

TØNSBERG, T. (1992) The sorediate and isidiate corticolous, crustose lichens in Norway. *Sommerfeltia* **14**: 1-331.

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HAS DUAL NOMENCLATURE FOR FUNGI RUN ITS COURSE? THE ARTICLE 59 DEBATE

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During the 7th *International Mycological Congress*, a conference symposium entitled, "Teleomorph and anamorph classifications in concert?" was organized by Paul Cannon (CABI Bioscience), Pedro Crous (Centraalbureau voor Schimmelcultures) and Keith Seifert (Agriculture & Agri-Food Canada). Following five presentations, a formal 1.5 hour debate on the future of Article 59 was held between two teams of three specialists, with Keith Seifert acting as a moderator. Article 59 is the part of the *International Code of Nomenclature* (reproduced below) that allows the application of two or more formal, Latin names for one fungal species, one for the teleomorph and an additional name for the anamorph, or more than one name if there is more than one anamorph.

The five presentations in this symposium provided context for the issue of dual nomenclature, and presented different opinions on whether the present system should be

Article 59

(from Greuter *et al.*, 2000, International Code of Botanical Nomenclature. St. Louis Code. Regnum Vegetabile no. 138. Copyright International Association for Plant Taxonomy)

59.1. In non lichen-forming ascomycetous and basidiomycetous fungi (including Ustilaginales) with mitotic asexual morphs (anamorphs) as well as a meiotic sexual morph (teleomorph), the correct name covering the holomorph (i.e., the species in all its morphs) is the earliest legitimate name typified by an element representing the teleomorph, i.e. the morph characterized by the production of asci/ascospores, basidia/basidiospores, teliospores, or other basidium-bearing organs.

59.2. For a binary name to qualify as a name of a holomorph, not only must its type specimen be teleomorphic, but also the protologue must include a description or diagnosis of this morph (or be so phrased that the possibility of reference to the teleomorph cannot be excluded).

59.3. If these requirements are not fulfilled, the name is that of a form-taxon and is applicable only to the anamorph represented by its type, as described or referred to in the protologue. The accepted taxonomic disposition of the type of the name determines the application of the name, no matter whether the genus to which a subordinate taxon is assigned by the author(s) is holomorphic or anamorphic.

59.4. Irrespective of priority, names with a teleomorphic type take precedence over names with an anamorphic type when both types are judged to belong to the same holomorphic taxon.

59.5. The provisions of this article shall not be construed as preventing the publication and use of binary names for form-taxa when it is thought necessary or desirable to refer to anamorphs alone.

59.6. As long as there is direct and unambiguous evidence for the deliberate introduction of a new morph judged by the author(s) to be correlated with the morph typifying a purported basionym, and this evidence is strengthened by fulfilment of all requirements in Art. 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45 for valid publication of a name of a new taxon, any indication such as "comb. nov." or "nom. nov." is regarded as a formal error, and the name introduced is treated as that of a new taxon, and attributed solely to the author(s) thereof. When only the requirements for valid publication of a new combination (Art. 33 and 34) have been fulfilled, the name is accepted as such and based, in accordance with Art. 7.4, on the type of the declared or implicit basionym.

Recommendation 59A

59A.1. When a new morph of a fungus is described, it should be published either as a new taxon (e.g., gen. nov., sp. nov., var. nov.) the name of which has a teleomorphic type, or as a new anamorph (anam. nov.) the name of which has an anamorphic type.

59A.2. When in naming a new morph of a fungus the epithet of the name of a different, earlier described morph of the same fungus is used, the new name should be designated as the name of a new taxon or anamorph, as the case may be, but not as a new combination based on the earlier name.

59A.3. Authors should avoid the publication and use of binary names for anamorphs when the teleomorphic connection is firmly established and there is no practical need for separate names (as e.g. in rust fungi and members of the *Trichocomaceae*).

maintained or drastically revised.

Martina Reblová (Institute of Botany, Czech Republic) and Gary Samuels (SBML, USDA-ARS, Beltsville) presented, "The practicalities of integrating anamorph and teleomorph taxonomies." They examined several groups of Ascomycetes where dramatic numbers of name changes would be necessary if fundamental changes were made to the concept of dual nomenclature.

Mary Palm (APHIS, Beltsville, USA) and Paul Kirk (CABI Bioscience, Egham) discussed, "Anamorphs, teleomorphs and users of names." They advocated a gradual approach to modifying the *Code*, with nomenclatural changes proceeding in concert with taxonomic revisions to avoid automatic name changes.

Gregoire Hennebert (University of Louvain, Belgium, retired) presented, "Dual nomenclature and classification in higher fungi: Six procedures to resolve it, with proposals to emend Art. 59," a detailed analysis of options for modifying the *Code* to accommodate different visions of the future of dual nomenclature.

Scott Redhead (Agriculture & Agri-Food Canada, Ottawa) presented, "The history of Article 59 and anamorph definitions - and a new twist: synteleomorphic names," reviewing the trail of ideas, articles and revisions that lead to the modern Art. 59.

Paul Cannon (CABI Bioscience, Egham, UK) and Keith Seifert (Agriculture & Agri-Food Canada, Ottawa) presented, "Consequences of deletion of Article 59 for economically important fungi." They emphasized the temporary status of the majority of anamorph generic and species names, and the desirability of formalizing several economically important anamorph genera as holomorph genera.

A summary of the presentation by Prof. Hennebert is published in this issue of Mycotaxon. The abstracts of all presentations were published in the "IMC7 Book of Abstracts."

This symposium and formal debate were organized following various forms of discussion and informal debate over the past decade. *The Holomorph Conference*, held in 1992 and published in 1993, was organized by Don Reynolds and John W. Taylor. One of its themes was that phylogenetic taxonomy based on cladistic analysis of DNA sequences would facilitate the integration of anamorph and teleomorph taxonomy and nomenclature. This integration was partly implemented in the last two editions of *The Dictionary of Fungi*. Following the *Holomorph Conference*, an Internet discussion group organized by Eric Swann considered the issue. At the 1999 *International Botanical Congress* in St. Louis, a session was held on what has come to be known as the "Genus for Genus Hypothesis". In this session, two separate presentations, the first by Paul Kirk (coauthored by Paul Cannon) and the second by Keith Seifert, called for the abandonment of dual nomenclature for fungi and equal priority at all taxonomic ranks for anamorph typified names (published in Studies in Mycology 45). In March 2001, David Hawksworth stimulated more discussion by circulating draft proposals to drastically emend Article 59, and this was followed by the formation of another Internet discussion group.

In Oslo, the focus of the debate was whether major modification of Article 59 was desirable, and whether mycological nomenclature should move to a system where only one name per fungus would be permitted. At the end of the debate and following discussion with the audience, a vote was held on a question set by the organizers. The following is an edited transcript of that debate and discussion. The verbal presentations have been edited for clarity, grammar, brevity and to minimize redundancy; where references to the literature were made by the speakers, an effort has been made to make these clear, short of adding a bibliography. The moderator's instructions and comments are removed except when they are required to provide context. CD copies of the recording of this debate are archived in the libraries of CABI-Bioscience, CBS and DAOM.

At the conclusion of his introductory remarks, the moderator projected paraphrased principles of nomenclature as stated in the preamble of the *International Code of Botanical*

Nomenclature.

International Code of Botanical Nomenclature - Principles

I-	**Independent of zoological nomenclature.**
II-	**Dependent on nomenclatural types.**
III-	**Dependent on priority of publication.**
IV-	**One correct name per taxonomic group.**
V-	**Scientific names are considered Latin.**
VI-	**Rules are retroactive.**

Opening statements

Hawksworth: It's very appropriate to consider these principles. Notice that Principle IV says one name per taxonomic group. The current rule actually enables fungi with pleomorphic cycles to have more than one name. This is as very unusual exception, not only within the botanical rules of nomenclature, but in biological nomenclature as a whole. Taxonomists working with other groups of organisms handle pleomorphy quite happily. They are quite content to have one name for one taxon. It is also important to remember that the current article does not refer to all fungal groups. It does not refer to oomycetes, chytrids, zygomycetes, lichen-forming fungi or slime moulds, most of which have distinct stages in their life cycle but only one name.

The current system originated because it was often unknown when sexual and asexual forms were part of one fungus. The idea of working towards a single name when connections were clear extends well into the middle of the nineteenth century, and had active proponents in later years as well. Where it was firm and clear, as the Tulasne brothers started to document most elaborately in *Selecta Fungorum Carpologia,* their major work of 1862-1865, they only used one name. Over 30 years ago, Martin Ellis used only the generic name for the anamorph if the teleomorph was known, in his books *Dematiaceous Hyphomycetes* and *More Dematiaceous Hyphomycetes*. He did not use the anamorph species epithet because he considered it illogical. For example, he used *Stemphylium* state of *Pleospora herbarum*. Nowadays, with cultural methods and molecular techniques, we can establish connections much more definitely than has ever been done before.

The existing system is very confusing to mycologists and biologists in general and will become increasingly so. How many mycologists have actually attended courses on nomenclature and had these things explained to them? I think very few indeed. At the 1993 International Botanical Congress in Tokyo, the suggestion was made that Article 59 be deleted altogether. Strong arguments were advanced, and there were similar debates at other conferences, but deletion was considered too drastic and was not approved.

We need to find a way to reach the one name-one organism situation and minimize disruption along the route. I've given this some thought, and in March 2001 I made some proposals that were sent to several well-known mycologists. These created a considerable furor. There were key elements in these proposals; a) restrictions by date governing when the new system would be implemented; b) provisions to allow designation of epitypes (technically, extra type material), to emend anamorph names if they were to operate as teleomorph names; and c) recommendations that where connections were known, informal referral to anamorph names should be made, rather than the proposal of formal scientific names.

It is important to realize that the rules of the present *Code* have changed considerably concerning what can be done by expert committees. It could now be possible to keep important anamorph names such as *Aspergillus* and *Trichoderma,* but apply them to teleomorphs as well.

Gams: Nomenclature provides a coherent set of rules to the benefit of users of names. As such, it is a basis for communication. Linnaean nomenclature has many compromises that are in conflict with strict phylogenetic thinking. Consider the artificial hierarchy of ranks and the acceptance of paraphyletic taxa. So it is also with the anamorph-teleomorph situation. Of course, it would be a most elegant situation if the nomenclature of pleomorphic fungi could adhere to general principle of one species-one name. But as decades of assiduous work have shown, such a solution is not workable in mycology. The provisions of Art. 59 have grown through time to satisfy the needs of identifying mycologists.

So far, all higher fungal taxonomy is morphology-based. Without understanding morphology, it is impossible to understand the function of a fungus. The strongest proponents for abandoning Art. 59 are molecular biologists with a low opinion of morphology. Replacing all identification work with molecular routines is a form of reductionism that I dare to oppose. Similarly, imposing a strictly unified nomenclature for molecularly identified fungi would be equivalent to surrendering to a fashion. Please do not misunderstand me. I appreciate the tremendous impact that DNA sequences have on fungal taxonomy. But if nomenclatural changes should now be enacted as a concession to this reductionism, I wish to protest.

I should clarify my position in view of my collaboration with Dr. Hennebert in his remarkable study on possibilities of modifying Article 59. Like him, I prefer his procedure 6, but I still prefer maintenance of a dual nomenclature and suggest that it is indispensable to the identifying mycologist.

The benefits and drawbacks of maintaining or abandoning dual nomenclature for pleomorphic fungi must be carefully balanced. The artificial separate naming of anamorphs has tremendous advantages when fungi are to be identified morphologically. In many cases, the anamorph predominates completely in culture and often also in nature, and often it offers decisive criteria for species separation. Unfortunately, anamorph morphology is generally inadequate to directly integrate an anamorphic fungus in a teleomorph system. Complete integration will work only if we achieve a one-to-one relationship of anamorph- and teleomorph genera and species, a situation that is unlikely to be achieved for several decades. At present, it is one of the major advantages of the separate nomenclature that anamorph and teleomorph generic limits often do not and also need not coincide.

It is often said that dual nomenclature inhibits mycologists from searching for teleomorph connections of an anamorphic fungus. Such an unscientific attitude cannot be blamed on Art. 59. On the contrary, every self-respecting mycologist strives to establish teleomorph connections of anamorphic fungi and to integrate them as far as possible in the teleomorphic system.

It is also often said that computerization and databases demand uniform nomenclature. Nothing is less true. Databases have all possibilities to correlate connected names in various ways. Especially if the correlation between anamorph and teleomorph species is not one-to-one, retaining both systems has advantages. Anamorph names (which are sometimes delimited in a broader sense) can be used in databases as well as teleomorph names when connections are proven beyond doubt with morphological or molecular methods. A prerequisite for unified nomenclature is the unequivocal connection between anamorphs and teleomorphs, but in practice often a broadly-interpreted entry will stand next to a strictly-interpreted entry for different isolates or specimens under the same name. This is the crucial problem with which databases struggle, not the dual nomenclature. In the CBS culture collection, we know of many cases that illustrate this situation and therefore some isolates are accessioned under the teleomorph name and others under the anamorph name. The two names are connected, so that all isolates will be retrieved easily by the user of the database.

It is important to inventory possible cases where dual nomenclature really hampers progress, and cases where dual nomenclature is of obvious advantage. We need to have concrete examples to discuss. Only when more complete databases for anamorph- and teleomorph names are established will it be possible to define the needs of nomenclature with a view to possible harmonization.

In conclusion, I consider even the most conservative Procedure 1 described by Hennebert to go too far in suppressing anamorph names entirely when teleomorph connections are established. Perhaps his procedure 6 is more realistic. But it prevents the legitimate use of anamorph names in pleomorphic fungi, with which I do not yet agree. Thus, I still defend maintenance of present Art. 59. The recent addition of Recommendation 59A.3 is an improvement to limit the number of new anamorph names. I do not deny that a unified nomenclature is an ideal goal but I do not see a solution unless morphology is completely abandoned as a taxonomic criterion in fungi.

Kirk: I support the retention of Art. 59, but in a modified form that puts the nomenclature of the past in order, and provides for that of the future: Preamble IV, of the ICBN. A future where each taxon at the rank of species or below has only one correct name: Principle IV of the ICBN.

When Fries developed his taxonomy of agarics, he relied on unaided observation, at most a hand lens. Without a hand lens, some identifications were impossible, but that did not prevent adoption of his taxonomy. For plant pathologists learning how to identify anamorphic fungi, many of which are important pathogens of plants, the tool required is a high powered compound microscope, to enable recognition of conidiogenesis. Without this tool, some identifications are not possible. That did not prevent the universal adoption of conidiogenesis as a mechanism for characterizing anamorphic fungi, not classifying them. Similarly, molecular tools are required and will be increasingly required to distinguish morphologically identical taxa, sterile forms, or unculturable fungi, whether anamorphs or teleomorphs. They can be used to determine whether an acremonium-like anamorph is a member of the Nectriaceae, or the Clavicipitaceae, or whether a chalara-type anamorph is a member of the Microascales or the Helotiales. They can be used to show that a species producing hypogeous basidiomata belongs in the same genus as the majority of related species producing epigeous basidiomata.

It is not important that the molecular tools be universally applied in all identification processes. We cannot avoid their use in taxonomic research. Identification and classification are independent activities and the advancement of one should not impinge on the other.

It is very confusing to the users of names, the customers of the products of taxonomists, to be required to use two different forms of a name when communicating, for example, about two plant pathogenic fungi. In the case of the graminicolous helminthosporia, with a mixture of holomorph and anamorph names, we have the crazy situation of two fungi pathogenic on the same plant requiring two different binomials in two different genera to communicate about these two monophyletic species. Is it any wonder that plant pathologists still continue to use *Helminthosporium* for these fungi?

This confusion prevents a clear understanding of fungi, hinders the adoption of new taxonomies, and marginalizes taxonomists who produce them. The *Code* prevents the use of the epithet of an anamorph name in a teleomorph genus, where it is a pleomorphic fungus. For certain groups of fungi, the presence of the teleomorph is not necessary to recognize its correct position in a teleomorph classification. When we see a powdery mildew, we do not use the name *Oidium*, we use the word *Erysiphe*, even when the material is anamorphic. How is this different from the taxonomic doubt inherent in describing a new discomycete in *Sclerotinia*, when it is in fact a *Botryotinia*, or a new mushroom in *Agaricus* when it should be *Micropsalliota*?

Is it such a problem to refer a fungus to any rank in the hierarchy? If we need a binomial, let's do what we do as taxonomists and go with the best fit. Replacing morphologically based identifications with molecular based systems and other systems is the future, and we must all work towards this future. A major revision of Art. 59 to resolve the nomenclatural problems of the past and to prevent the use of dual nomenclature is required. The problem is not the rules, but the way we understand the words used to communicate. It is a problem for *Homo sapiens* to resolve, not the *Code*, whether the *Code* is changed or not.

Korf: I served the Special Committee for Fungi and Lichens for many years and preceded Dr. Gams as its secretary. I have seen the *Code* change several times.

Historically, when anamorphs appeared at different times and different places from their teleomorphs, it was deemed necessary that they have separate names. At one point, in fact, the *Code* determined that fungi could have only one name and that once a holomorph was known to have both teleomorph and anamorph, the teleomorph name was the only one permitted. Thus, once *Botrytis cinerea* was discovered to be the same fungus as *Botryotinia fuckeliana, Botrytis cinerea* was supposed to disappear from the terminology. This didn't work. Phytopathologists, in particular, need names for the things they see, and they never saw *Botryotinia fuckeliana*. They saw *Botrytis cinerea* all the time, they said they would continue to use that name and they did. So we changed the *Code* again to permit a dual nomenclature at all times for such fungi. The practitioners of mycology, in this case plant pathologists, dictated what we did with the *Code of Nomenclature*.

Are we really discussing nomenclature or taxonomy? I think there's a lot of confusion in people's minds. What we forget is that for nomenclatural purposes a name is permanently and directly connected to a type specimen. The application of that species name, whether it be by a plant pathologist or by a taxonomist, involves a concept or a circumscription. My concept of *Botrytis cinerea* is different than Dr. Gams' and Dr. Pitt's, because all that must be the same is that the type specimen of *Botrytis cinerea* be included. How broad or how narrow those circumscriptions are has nothing to do with nomenclature, and everything to do with taxonomy. Anamorphic names convey all sorts of information. If we suppress anamorphic names because they seem to be synonymous with teleomorph names, or because a holomorph genus may have several different kinds of anamorphs, we discard the kind of information that anamorphic names can represent.

Dr. Kirk mentioned the graminicolous helminthosporia, and this beautiful arrangement where *Cochliobolus* correlates with *Bipolaris*, *Setosphaeria* correlates to *Exserohilum*, and *Drechslera* correlates with *Pyrenophora*. If we reconsider the wonderful work by Ellis already mentioned, I suggest that his was a dead hand on the development of the taxonomy of this group. He did not accept the three genera of anamorphs involved; he called them all *Drechslera*. He suppressed the information that each one of these things was different.

I think we cannot tinker further with Art. 59. Every time we have tinkered with it, we have made the situation worse. We had better live with what we have, and develop a system with dual nomenclature that conveys information.

Berbee: Whatever you might think about nomenclature, the biology is clear. A typical fungal genome has about 40 million base pairs of DNA. Within that typical fungal genome, there are about 10000 genes and roughly 1000 of those genes code for morphological structures, either sexual or asexual. The rest of the genes do other things. So, is it truly reductionist to accept DNA evidence for relationships when the actual proportion of the genome that codes for something visible turns out to be exceedingly small? The smallest sliver on the pie chart (Fig. 1) is the amount of DNA that codes for something that you can see.

Many elegant studies have shown that the sequence of almost any gene, or almost any sequence from other areas of that chart, and can be used to delimit a species that has some sort of biological or phylogenetic sense. Fungi aren't like fossils. There is an unlimited source of information. A sterile mycelium has the same genes or almost all the same genes as the most beautifully sporulating hyphomycete.

So my first point is that the biology is absolutely clear. Even sterile mycelium has enough information to adequately classify the organism.

My second point is that things change. Who would have guessed that the Berlin wall would be torn down? Who would have guessed that Germany and France would come to share a common currency?

My third point is that nomenclature is indeed separate from biology, or separate from taxonomy anyway. Opinions differ as to how to handle the naming of taxa. I'd like to conclude with the results of an informal survey I made among famous mycologists at this meeting. I

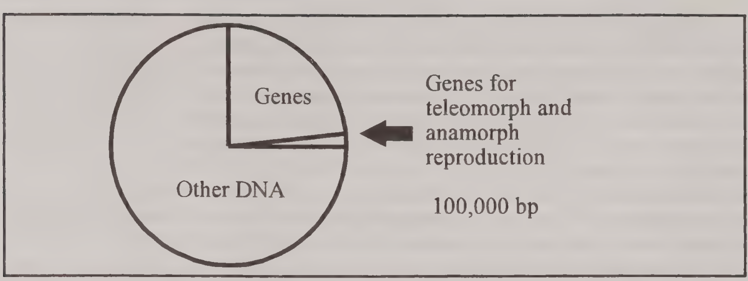

Fig.1. Proportion of DNA coding for morphological structures traditionally used for taxonomy, vs. other genes, and non-coding DNA.

asked the question, "What do you think should be done about Art. 59?" Here are some of the responses:

David Geiser: Zoologists and botanists think we're insane. Use a single name per organism as long as we can continue to use anamorph names when they are better.

Teresa Iturriaga: If changes are made, make them slowly. It's tough!

Sharon Cantrell: There should be one name per species, whether it is sexual or asexual.

Emory Simmons: It's ridiculous to try to do anything, because the people who use the current system are familiar with anamorph names. What about the connection with the literature?

Nicholas Money: Can anyone delimit a single fungal species in a way that make sense to other biologists?

Amy Rossman, Lisa Castelbury: Try hyphenation.

Nigel Hywel-Jones: If we can hyphenate my name, why can't we hyphenate fungal generic names?

Rasoul Zare: To be practical, Art. 59 is needed for another 5-10 years.

Junta Sugiyama: Fungi should be united in one phylogenetic tree, but anamorph and teleomorph names should be retained in practice.

Susan Kaminskyj: Fungal names should relate to the dominant part of the life cycle.

Scott Redhead: Art. 59 has served a useful purpose, and continues to serve a useful purpose, but it needs an escape valve.

Don Pfister: I've never named an anamorph in my life. We now have the tools to analyze fungi regardless of anamorph/teleomorph connections. The names are now less important, but some consistent naming is needed."

And with that, I've summarized my opinion, as well as a range of opinions, about what to do about Article 59.

Pitt: I'd like to talk about a large constituency of users of taxonomy who haven't been mentioned so far. This constituency includes food manufacturers, indoor air specialists and biotechnologists. They work with several groups of fungi, but the family Trichocomaceae is the main one. This is a relatively small group but many commercially important species fall into this family, which I've worked on for many years. And here dual nomenclature, two names, has always been very important.

By definition, food is nutritious and fungi constantly threaten the world's food supply. Many mycologists are involved in naming fungi that cause problems in cereal manufacturing, baked goods, meats, cheeses, and so on. These fungi grow readily in culture. Some make ascospores and some don't. Many years ago, my colleague Ailsa Hocking and I decided that we would use teleomorph names for species that produced teleomorphs in culture, or if we felt that they had occurred during the food manufacturing process. We have expended a lot of effort teaching our clients to use teleomorph names in situations where these are important to them. If we mention *Byssochlamys, Eupenicillium* or *Neosartorya* to food manufacturers, they know immediately that they are dealing with a fungus that makes ascospores. Ascospores are heat- and chemical-resistant. They survive pasteurization; so if they occur in products, they are likely to come entirely from raw materials. If we mention *Penicillium, Paecilomyces* or *Aspergillus*, our clients know immediately that they are not dealing with heat-resistant ascospores, but only with conidia. These arise in the factory from contamination in the system and can be fairly easily removed with processing treatments.

For this reason, we really need names that relate specifically to whether a fungus makes ascospores or not. To make a change in either direction, by using *Eupenicillium* exclusively, or by using *Penicillium* exclusively, will remove information that is enormously useful to people who provide us with food. Yes, it may be possible to make these changes, but it would cause huge confusion to a large constituency of users.

Dr. Kirk has emphasized that many connections remain to be made, with the implication that eventually nearly all anamorphs will be connected to teleomorphs. I suggest that this is patently inaccurate. The fungi that I work with in many cases not only just do not have a teleomorph that has not been found, they don't have them at all. They have ceased producing teleomorphs and are strictly anamorphic fungi. Fungi like *Aspergillus flavus* and *Penicillium expansum* are extremely important in the real world but they do not have teleomorphs. Their names should not be changed under any circumstances, no matter what rules phylogeneticists might dream up to make life simple.

I'm a simple person and I really like simple solutions. But here, any simple solution is simply simplistic. We are dealing with a complicated situation. We have a system that serves us very well. Taxonomists working with the family Trichocomaceae have spent the last 15-20 years establishing a framework that is neat, clear, and well established. We use dual nomenclature when we have to, we use teleomorph names when they make sense, and we use anamorph names when there is no teleomorph. Please, the system ain't broke. Let's not try to fix it.

Rebuttals

Hawksworth: I'd just like to make two points. First, regarding Dr. Pitt's concerns about information content, under my proposal it would still be possible to informally refer to the states of particular taxa using names that aren't scientific names, as did Ellis (see above).

Second, Dr. Korf pointed out that tinkering with the *Code* can cause problems. If the research is done properly, as it was when we changed the starting point date for fungi, we can actually guard against most potential problems beforehand. This is why this debate is being held and we're not rushing to make proposals immediately. Most current concern is that there might be a lot of name changes in anamorph genera such as *Aspergillus, Penicillium* and *Fusarium.* I'd like to point out the huge number of names lurking in *Sphaeria*, which were ruled invalid under previous versions of Art. 59, but that have all now become valid. Nobody has started to work through them revising coelomycete nomenclature yet. There's a minefield of name changes waiting in some groups if we keep the rules the way they are. Fortunately, most taxonomic mycologists actually have been very cautious in not implementing Art. 59 as it currently applies.

Gams: Dr. Hawksworth has been running through many open doors, especially concerning the application of cross-reference names such as, for example, the *Bipolaris* anamorph of *Cochliobolus sativus*. This is the preferable name. The recent addition of recommendation 59.8.3 to the *Code* is an improvement intended to limit the number of new anamorph names. In this particular case, where there is complete congruency between the anamorph taxon and the teleomorph taxon, I fully agree with the desirability of this strategy to reduce the number of names. But in other cases, such as in *Botrytis cinerea* and *Botryotinia fuckeliana*, there is not a complete congruence, and both names are needed because they mean different things.

I agree with Dr. Berbee and have not the slightest doubt about the reliability of molecular data for the perfect identification of taxa. We will certainly find specific DNA fragments that will do the very best job and we will have an absolutely unambiguous system. But are we really going to abandon morphological identification completely?

A point that has not yet been mentioned in this debate, but was discussed by Prof. Hennebert earlier in the session, is that we actually have an abnormal situation in the typification of fungi. There are different kinds of typification, such as the anatomical anamorphic typification, and holomorphic typification that requires the presence of teleomorphic elements in the type specimen. The most controversial issue among Dr. Hawksworth's ideas is the concept of expanding the status of an anamorph -typified generic name by epitypification. That is really a matter to be discussed more extensively. Because my time for rebuttal is very limited, I cannot go into detail here.

Kirk: Dr. Pitt provided very convincing arguments for retaining dual nomenclature, but I have one question. What happens when we induce the formation of the teleomorph of one of his *Penicillium* species? Do we use a teleomorph name, or do we completely ignore Art. 59? Databases can assist in the transition. They are critical.

To refer to Dr. Gams' comment, why is morphology critical for identification? How do you apply morphological identification to a sterile culture? How do you apply morphological identification to an unculturable fungus?

Polyphyletic anamorph genera will continue to be revised, largely based on molecular data. In fact, some of the most active workers in this area are on the other team.

If Art. 59 is so vital for assisting communication, why have we not extended it to all the fungi?

Korf: I understand the position of the other team, but mention as an example the genus *Alternaria* with about 600 species, of which only eight have a known teleomorph. I'm not about to abandon the name *Alternaria* and adopt the teleomorph name for these.

I'd like to point out that dissection of anamorph genera is not limited to mycologists who are working with DNA. I'm thinking of the elegant work that Dr. Simmons has done in *Alternaria*, and that Dr. Morgan-Jones and his students are doing with *Botryobasidium* anamorphs in genera such as *Haplotrichum*. This kind of work convinces me that molecular data can help, but it is looking down the microscope that ends the story.

Berbee: In defence of DNA sequencing, I do believe that this will become the standard for identification because in most cases it is cheaper and it requires less time than training a competent morphologist. In contrast, in two months I can train someone with good lab skills to identify a *Penicillium* species from a database. Of course, having that species of *Penicillium* correctly identified in the database is an important prerequisite. And part of the reason that it might be correctly identified in the database is because of the work of Dr. Pitt.

Another point I wanted to make is that users change. A new group of users graduates every year and these are the students that we teach. Most of us who teach notice that it's often the bright students who think it's crazy that one fungus needs two names. Our generation of scientists is going to be gone in 50 years and there will be a whole new generation using fungal names. They will forget whatever we did, except for when they return to our literature with the help of databases.

Pitt: Dr. Kirk talked about the importance of anamorph-teleomorph connections, and of doing the work to establish firm connections. The result might be that we will be able to use one name but we'll have to connect the concept somehow to the name of the anamorph that people have routinely used. I suggest that users of taxonomy don't really care about connections. What they care about is the identity of the fungus they've given to the diagnostician. They say, "This is the form on the plant or in the factory. It has certain characteristics and I'm not concerned about unseen morphs. The thing in front of us is what matters." As Prof. Korf has already explained, this is the reason that we use the name *Alternaria* instead of *Lewia,* for example. What we see most of the time are *Alternaria*s. It would take a whole generation to switch to talking about *Lewia,* when the connections occur only in the laboratory, and out in the real world are hundreds of *Alternaria* species with the real morphology that we work with.

Dr. Berbee made the point that only a few genes control morphology. This is perfectly true. But she didn't mention that slight differences in morphology can indicate differences in other characteristics of the species. For example, let's consider two species of *Penicillium, P. expansum* and *P. crustosum*. Few genes are likely to be involved in the differences in their morphology, but even with those slight differences, we see them as different species. One is a major apple pathogen and the other occurs on meats. One makes patulin, a minor mycotoxin, the other penitrem A, a huge molecule with a whole different set of biochemical pathways. A minor change in morphology often reflects differences in a lot of the genome. We're not just talking about the few genes that change morphology at all.

And finally, we should stick to binomials and avoid trinomial or cross-reference names. People are used to binomial names. Talking to people in industry about the *Penicillium* anamorph of *Eupenicillium somethingoranother* is a waste of time. We should stay with binomials, whatever else we do, and whatever other mess we make.

Final arguments

Hawksworth: The case is very clear. We need to relate fungal nomenclature to the modern world and the basic principles of biological nomenclature. The real issue is how we actually make the changes. We have some proposals that need refining to minimize the impact on users of names. We have to move slowly. We have to make exceptions possible with the conservation procedures to prevent undue disruption in names of economic importance. I think that provided we do the research, progress by having open debates and discussions, that we can devise a system that will make sense to biologists and users at large.

Gams: In certain examples, such as *Alternaria* and *Lewia*, it is very risky to use the teleomorph name exclusively, even when the connection is well-established, as with *Alternaria infectoria* and *Lewia infectoria*. How many of us can identify anamorphs accurately enough to establish the absolute identity of these two? Here, it is certainly wise to stick to the anamorph name if only the anamorph is present. As Dr. Pitt has mentioned, the taxonomy of *Penicillium* and *Aspergillus* is progressing very rapidly. Species are identified reproducibly and reliably based on the phenotype, not only just the morphology but using secondary metabolite profiles, and this is perfectly confirmed by molecular data. In some cases, phylogeny deviates from the chemical connections. In some *Talaromyces* teleomorphs of this particular group, Japanese researchers have shown that ascospores are much more diagnostic than the anamorphs. So in that case, I would plea for exclusively using the teleomorph name.

When do we need to use DNA for identification? Sterile mycelia have been mentioned as a model case where DNA analysis is indispensable. For some unculturable fungi, such as *Glomus* and many other arbuscular mycorrhizal fungi, DNA analysis is problematic because of the occurrence of multiple, heterogeneous nuclei, but it is also very illuminating. But imagine going into the field looking for agarics with DNA analysis as a replacement for the instant recognition of species by the expert, and trying to do ecological work in this way? Here morphology is absolutely indispensable. In his presentation, Dr. Redhead presented a proposal that is worth considering to grant teleomorphic application in exceptional cases to an anamorph genus by conservation. Still, I wonder how many examples of this kind could be defended? I am still very sceptical.

Questions and remarks from the audience

Scott Redhead (Agriculture & Agri-Food Canada, Ottawa): There will be a question at the end that people will vote on. Is there a predetermined question that can be modified? We should have this in our minds during the discussion.

Seifert- It's a relatively straight forward question.

Do you prefer:

A- Continued use of dual nomenclature.
B- A system with one name per fungus, teleomorph names only.
C- A system with one name per fungus, anamorph names allowed in some way.

Please select one answer only.

Gregoire Hennebert (University of Louvain, Belgium, retired): Alternatives B and C could go together because whether the anamorph name or the teleomorph name should be used depends on the details of each case. The anamorph name could be kept when it is in current use. The teleomorph name should be kept when the anamorph name is less used. Stability of nomenclature should be paramount. It is clear that very important names such as *Fusarium, Penicillium* and other anamorph genera should be kept.

Seifert - I'd prefer not to discuss the question. The organizers and team captains discussed this, and some people would still prefer option B.

David Minter (CABI Bioscience, Egham, UK): You may not want to discuss the question, but I do. This is not one question. Here we've got two questions, or at least, more than one. We're being given the option of continual use of dual nomenclature or some sort of single nomenclature. But we're also being asked what sort of single nomenclature and indeed we are not being given all possible options. As it stands, it's not clear how you will count the votes. The votes for a single nomenclature are divided. If you get 100 votes for dual nomenclature, and 60 votes for B and 60 votes for C, is it possible to say that A won when in fact B and C added together will be in favour of a single nomenclature. We really need to have the first question, "Do you want a single or a dual nomenclature?" and then, "What sort of nomenclature do you want?" Will the moderator and will the teams consider this question?

Kirk: There can be two results, or course. The first result can be either A or B+C. And then, either B or C. And that would answer your question.

Seifert: We tried to keep it a simple question but perhaps we were too cute in formulating it this way. I'd like to clarify that this debate has no formal status. This is a discussion among colleagues. We need to deliver an idea of what the mycological community is thinking to the people involved in developing nomenclatural rules. The mechanism is really up for the formal committees to decide. There is the possibility of spoiling your ballot if you really object to making one of these choices. This will be evident from the results.

Maria Teresa Gonzalez Jaen (Universidad Complutense de Madrid, Spain): I support the option of one name per fungus. As biologists, we should be adding order and clarity to the Tree of Life. Many years ago, we accepted that the Tree of Life should be phylogenetically accurate. We can't put two names on branches; we should only use one name. Dual nomenclature may be useful for people identifying fungi using morphological characters. In reality, many people no longer identify fungi using morphological characters and this will be more and more the case. For the Tree of Life, we should have one name on the branch, one name in the books, and we should discuss which name should be chosen, the teleomorph or the anamorph. These discussions should be held by people qualified to make the decision. Otherwise, individual researchers will make their own choices and eventually many names will be well-established without an appropriate technical basis. If we don't change the rules now and don't adopt the use of one name, then users will do it for us.

Korf: Elsewhere in this conference, there was a presentation on the basidiomycete genus *Hyphoderma* that showed that species attributed to this genus occur in seven of eight clades in the family/order. Which one of those clades do the molecular people want us to apply that name to?

Berbee: The one with the type, of course.

Korf: We can't tell those genera apart.

Thomas Kirisits (Institute of Forest Entomology, Forest Pathology and Forest Protection, BOKU University, Vienna, Austria): If I have found an asexual fungus, if Art. 59 is deleted and I don't have access to DNA facilities, can I still describe the fungus as a new species without establishing its phylogenetic relationships using DNA? If deleting Art. 59 means that, this would suppress a lot of mycology in the world. It is not true that there is molecular equipment everywhere in the world. Many people still depend exclusively on morphological methods. They know their fungi well and identify them reliably without access to DNA equipment.

Hawksworth: If you have an asexual fungus only, Art. 59 does not apply at all. With the present rules, it only applies where you have both states. So if you have an anamorph only, you are free to do what you wish and there are no constraints whatsoever.

Kirk: Technically, when you describe a fungus, you introduce a binomial: that's nomenclature. You do not place the fungus in a classification: that's taxonomy. If you wish to describe a fungus as a species, you introduce a binomial and choose the most appropriate genus. If there isn't an appropriate genus, you introduce a new genus. You don't have to comment on which family it belongs in.

Kevin Kuehn (Eastern Michigan University, Ypsilanti, USA): I`m a fungal ecologist who is confused in general about the state of fungal taxonomy and I'm confused about this. My research concerns emergent macrophytes in wetlands and their decomposition. If I try to determine the major taxa associated with decomposition of that material, and find a preponderance of anamorphic species, coelomycetes etc., what am I going to do? How am I going to identify and describe them when I publish my work? From what I understand, I'm going to need to do molecular work to identify these fungi. The names are going to be gone.

David Yohalem (Danish Institute of Agricultural Sciences, Tjele): I'd like to respond to Dr. Berbee's suggestion that with a two month training period, she can produce a mycologist who mine a database to identify a fungus. That's not a mycologist.

Berbee: Actually, I didn't say anyone could become a mycologist in two months, but that you could learn to identify a *Penicillium* from a database. Perhaps I need to be more exact about what I believe about how DNA sequences contribute information about species. I believe you can describe species based on morphology, but you're going to be wrong sometimes about its classification. Sometimes the molecular data will help you be more precise about the relationships of the new species.

Amy Rossman (SBML, USDA-ARS, Beltsville, USA): I'd like to ask the team who favour changing Art. 59 more about how they propose to change it. That's unclear and it's very important. Some people might assume teleomorph names should have priority. This is not what we need because often the anamorph is the predominant state. For many fungi, the teleomorph is rarely encountered. Dr. Korf's argument about *Botrytis* illustrates this well, and abandoning anamorph names entirely would not be accepted. This may be an issue primarily at the generic rank, even though Art. 59 deals with species. Because of molecular data, we're really talking about clades that would be interpreted as genera. Which generic name would be given priority? Would we give the oldest name priority? Would we give priority to the teleomorph, or the anamorph, or the predominant state or would we form a committee to decide? I agree with Dr. Minter, and I can't vote based on this question.

Hawksworth: Because of the problem of coping with the past as we look to the future, we made some minor changes in the article at the St Louis International Botanical Congress, to discourage the introduction of two names when both morphs were known in a life cycle. Often two names are proposed in the same publication for one fungus, sometimes on a single page. We need to be stricter about this. This has initially been discouraged with a Recommendation. It will take time to implement one name for one fungus and even in that situation, it should still be possible to indicate the most important state in an informal way, if we wish. Gradually, probably through a body like the International Commission on the Taxonomy of Fungi, we can identify the particular anamorph generic names that are advantageous to keep for the whole fungus. *Trichoderma, Aspergillus* and *Colletotrichum* and so on, are certainly ones to be debated from that point of view. As we are all aware, scientists working on these groups generally don't use the teleomorph names anyway. The people who work on *Trichoderma* are sure to use the name *Trichoderma* when they publish, and only rarely are *Hypocrea* names mentioned. Scientists working with *Aspergillus* species must of course continue to use *Aspergillus* names. Each situation would have to be looked at specifically. We would have to move gradually, being conscious of the different situations that occur in different groups of fungi. We must prevent the problem from growing and work towards rationalizing what we've got now. I don't see why that cannot be done.

Pitt: Dr. Hawksworth says we are now discouraged from proposing two names when describing something. With some of the fungi I work with, an isolate may contain both a teleomorph and an anamorph. But other isolates of the same species only produce the anamorph. This is a very strong reason for proposing two names, because we don't know what proportion of isolates actually are going to have the teleomorph. Some species include cultures that make a teleomorph, others make sclerotia, and some make nothing like that at all. They are still the same species quite obviously from appearance; I don't need DNA to show this. I need the two names because we get some with teleomorph and some without.

Kirk: Was that a proposal to extend Art. 59 to all the three Kingdoms that we study?

Pitt: I have no interest in extending Art. 59. It does what it needs to do now for the fungi that we work with.

Korf: I'm concerned that with the way we've now tinkered with Art. 59, one person will decide to use only the anamorph name, and the next person dealing with the same genus is going to use only the teleomorph name, when he has both states available. I'm not sure this is an advance.

David Geiser (Pennsylvania State University, State College, USA): I curate a *Fusarium* culture collection and support option C for obvious reasons. Of course, this choice says, "...by some mechanism" for how we would incorporate the anamorph names. That's very important. I wouldn't want to see some people describing *Nectria* and *Haematonectria* species and others describing *Fusarium* species. There would have to be a mechanism to prevent that from happening. My second choice would be retaining dual nomenclature, because it would be a disaster to lose names like *Fusarium, Aspergillus* or *Penicillium*. But why does Dr. Pitt think that people working with food should have two names if nobody else does? We all face the same problem of trying to force all the biology of a fungus into a single Latin binomial. Scientists working with forest fungi don't get the benefit of describing separately the mycorrhizal state of *Suillus pungens*.

Pitt: We use the teleomorph name where the teleomorph is known because it produces ascospores and the problems that occur in the food industry and in many other industries relate to the properties of those ascospores. We don't use *Aspergillus* when we have the *Eurotium* or a *Neosartorya* because the teleomorph name expresses the overall function very effectively. We use *Aspergillus* only when the teleomorph doesn't exist. This might be confusing to those who don't deal with this kind of system, but it works well for us.

Jack Rogers (University of Washington, Pullman, USA): Without commenting on these three choices, I would like to say that I like flexibility. Let's suppose that I'm working with the genus *Xylaria*. If I'm working with a *Xylaria* that has its anamorph on the immature clava, this is fine. When we describe this, we'll say, "This anamorph is *Geniculosporium*-like," describe the thing, describe the culture, and let it go at that. But we have other *Xylaria* species in which the anamorphs are separated in time and space from the club. In this case, if we've got one of these things in the genus *Xylocoremium*, and there are different species of *Xylocoremium*, we may well want to give this thing an anamorphic name. So I do like the flexibility.

Lene Lange (NovoZymes, Copenhagen, Denmark): I work in the biotechnology industry and choice C could serve our purposes well. It includes flexibility and would add some clarity to the patenting process. Choice B would be a very bad solution from our perspective.

Another point is that I do not think that the discussion of whether species are defined by morphology or using molecular phylogenetic concepts by DNA is really germane to the discussion of nomenclature.

Vincent Demoulin (University of Liège, Belgium): I'm a long time member of several nomenclatural committees, including the editorial committee of the *Code*. I don't consider myself a specialist in anamorph taxonomy or nomenclature but I remember a similar debate at the 1983 Tokyo International Mycological Congress, and since then I have been scratching my head about this problem. My intervention mainly relates to the presentation by Paul Cannon immediately before this debate. I'm one of many who is dissatisfied with the *Black Code* and would have preferred that we had adopted several important improvements in the *Code* in St.

Louis. But please don't have the impression that the nomenclature *Code* should be discarded and replaced by something new. This is not a cook book, it is really a code, a legal instrument. Perhaps because the British started earlier they no longer have the same sort of interest in having a constitution, as do France and countries influenced by the French revolution, including the United States. I think that legal documents should evolve but with great caution. We should not throw it away suddenly and start a new one. It is very important in any democracy that the founding principles are kept relatively intact. Only adapt them when adaptation are really necessary. So this is just a plea for caution.

Wendy Untereiner (Brandon University, Canada): Dr. Redhead's recounting of the history of Art. 59 has been very helpful. I'm wondering why things are so clean in the lichens and the zygomycetes? I was always aware that life cycles were a bit more complicated with the black yeasts that I work on. I guess our use of dual nomenclature reflects the enormous diversity in morphology and in diaspore form in the Dikaryomycotina, that may not exist in other groups. Dual nomenclature is the mechanism by which we have to deal with it. With respect to the choices proposed for voting, I don't think option B is the one that I would pick. I'm in favour of retaining information about organisms. What needs to be stressed is that dual names do convey a lot of ecological information about organisms. Dr. Berbee claimed that the biology is clear. It isn't. The phylogeny is clearer, but to reduce our taxonomic system to genes is to lose a lot of information about biology that we should try to keep.

Results of the vote

A- Continued use of dual nomenclature.	121
B- A system with one name per fungus, teleomorph names only.	9
C- A system with one name per fungus, anamorph names allowed in some way.	75
Spoiled ballots:	~ 10

Postscript

This issue was again addressed at the *8th International Congress of Plant Pathology* held in Christchurch, New Zealand, February 2003. In a mycology session, Pedro Crous presented a talk on, "Anamorph and teleomorph names in plant pathology: Present realities and future possibilities," which was essentially a summation of the opinions and views presented in the Oslo session. At the end of the talk, the audience of mostly plant pathologists, was asked to vote on a similar set of questions as that posed to the mycologists at Oslo. Results from this vote were as follows:

A- Status quo for anamorph and teleomorph names	83
B- Accept teleomorph names only	6
C- Accept anamorphic holomorphs via some adaptation to Art 59	56

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FUNDAMENTALS FOR SUPPRESSION OF DUAL NOMENCLATURE IN PLEOMORPHIC FUNGI AND INTEGRATION OF ANAMORPHIC FUNGI (DEUTEROMYCETES) INTO THE ASCOMYCOTA AND BASIDIOMYCOTA

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Abstract. Fundamentals are summarized for an envisaged suppression of dual nomenclature in pleomorphic fungi and integration of the deuteromycetes into the Asco- and Basidiomycota. A detailed text is presented on the websites of CBS (www.cbs.knaw.nl) and MUCL (www.belspo.be/bccm/mucl.htm) entitled "Possibilities to amend or delete Article 59 of the International Code of Botanical Nomenclature to achieve a unified nomenclature and classification of the fungi," by G.L. Hennebert and W. Gams.

Keywords: Code Article 59, unified nomenclature, typification, anatomical and botanical systems.

Since 1905, Art. 59 (originally 49bis, then 60 and 52) of the International Code of Botanical Nomenclature (ICBN) has permitted, except for lichen-forming taxa, the use of one or several anamorph names in addition to the teleomorph name in pleomorphic Ascomycota and Basidiomycota, thus creating a dual nomenclature. This dual nomenclature is based on anatomical typification, in which anamorphic material can only serve to typify the name of an anamorph taxon with restricted anamorphic application, while teleomorphic material can typify the name of a teleomorph with holomorphic application. This is the opposite of botanical typification used in zoosporic fungi and Zygomycota. The rule was originally intended to deal with pleomorphic fungi only, according to its title, but from 1930 onwards names for anamorphs of pleomorphic fungi could be created but, as with names of non-pleomorphic anamorphic fungi (deuteromycetes), such names were deprived of holomorphic application. Art. 59 and anatomical typification apply only to all morphs of non-lichenized "higher fungi."

Phylogenetic research helps fungal taxonomy by virtue of being well-accepted and fundamental. Therefore the distinction of anamorph and teleomorph names, granted by Art. 59 of ICBN as an exception to Principle IV of the ICBN, is strictly speaking no longer needed. To many mycologists dual nomenclature is an undesirable anachronism.

To achieve a unified botanical nomenclature of the fungi, it will be necessary, from a certain date onward, to extend typification of any taxon to holomorphic application. In the process of unification, three *goals* must be addressed:

1. Retention of one name instead of two or more names in pleomorphic fungi, i.e., removing dual nomenclature.

2. Conversion of anatomical nomenclature of the higher fungi into traditional botanical nomenclature by attributing holomorphic application to all names, including those of non-pleomorphic anamorphic fungi.
3. Integration of the anamorph classification into that of the higher fungi.

Because of our history of a dual nomenclature for some fungi, changing immediately, without preliminary evaluation, to allow any fungal morph to typify a holomorph would cause nomenclatural havoc. Attempting to achieve these goals with limited nomenclatural disturbance has led to the formulation of six possible *procedures,* which are fully described on the websites of CBS (www.cbs.knaw.nl) and MUCL (www.belspo.be/bccm/mucl.htm)

THE FIRST GOAL

Removing the dual nomenclature of pleomorphic fungi means that one or another name of the taxon is retained while the other names are suppressed from use. The same principle is applicable to pleoanamorphic fungi.

Mechanisms for selecting one name

Four options are already available under the Code and three mechanisms will serve to eliminate redundant names.

A first option is **priority** amongst synonyms, but is only available if the competing names have holomorphic application. This is **Mechanism 1**.

A second option, the declaration of **illegitimacy** of names (Art. 6.4-5, 18.3, 19.5, 52.1-3, 53), would be inappropriate for the suppression of alternate names of pleomorphic fungi, as illegitimate names are rejected and cannot be restored. It often happens that the organic connection between morphs of pleomorphic fungi is refuted and their names should then be restored.

A third option, **explicit rejection** of names (Art.14.1, 56.1) is also not appropriate because rejection is not reversible. For pleomorphic fungi a reversible mechanism is needed.

A fourth option is hidden in an exception in the rules concerning sanctioning and conservation (Art. 14.10, 15.2): prior homonyms of sanctioned and conserved names are not rejected but made *unavailable*, remaining *legitimate*, thus repressed from use, and *restorable*. This is very similar to our proposed **Mechanism 2, protection/repression**.

Art. 59 does not reject names (epithets and generic names) typified by anamorphs (henceforth called ana-typified) but it *restricts* them to anamorphic application, attributing *precedence* and *holomorphic application* only to teleo-typified names. Applied to generic names, **precedence/restriction** is used in our bipartite **Mechanism 3,** combined with protection/repression.

The only mechanism, in addition to priority, able to suppress dual nomenclature in epithets, is the reversible protection/repression. For instance, teleo-typified epithets are protected, ana-typified epithets are repressed from use. Precedence/restriction applied to epithets would create dual nomenclature. But both precedence/restriction and protection/repression can be applied to generic names.

1. Priority, when strictly applied to existing alternate names of pleomorphic fungi, would cause nomenclatural havoc. Frequently anamorph epithets and generic names have been coined prior to teleomorph epithets and generic names. Although this usually is not the case in all pleomorphic species of a genus or for all anamorph genera, a number of new combinations would become necessary. The absence of strict correspondence between anamorphic and teleomorphic genera, and the large number of non-pleomorphic anamorph species requiring a place would require a number of new generic names. To evaluate how great the ensuing "chaos" would be, a complete inventory of the pleomorphic fungi must first be made. However, priority *is* the mechanism to be applied in naming new pleomorphic fungi in any forthcoming botanical system.

2. **Protection/repression** can be applied to **both epithets** and **generic names**. Here teleo-typified epithets and generic names are protected, ana-typified epithets and generic names are repressed, but they remain legitimate and restorable. Conspecific anamorphic species are classified in the teleo-typified genus. Difficulties arise when species of an anamorph genus are connected to teleomorphs in different genera, and the other anamorphic species of the genus remain of uncertain affinity.

3. A bipartite mechanism, **protection/repression** applied to **epithets** and **precedence/restriction** to **generic names**, would offer a solution in which precedence is assigned to teleo-typified generic names. Ana-typified generic names remain available but are restricted to anamorphic application available for purely anamorphic species, even if the type species of the genus is teleomorphic. That bipartite mechanism would remove dual nomenclature of species and retain anamorph-generic names available for anamorphic species. At the generic level it is remiscent of Art. 59, but it would solve the difficulty of heterogeneous anamorph genera.

Two possible options, A and B

In order to preserve the best-known ana-typified epithets and generic names, *each mechanism can accept selected exceptions*.

Option A in mechanism 2 automaticaly protects all teleo-typified epithets and generic names. In mechanism 3, it automaticaly protects teleo-typified epithets only and gives precedence to all teleo-typified generic names, without exceptions.

Option B permits **selected exceptions:** well-known and commonly used ana-typified epithets and generic names may be **protected with holomorphic application**, and the less used teleo-typified epithets and generic names are repressed (mechanism 2); under mechanism 3, ana-typified generic names with holomorphic application *must* be protected, instead of having precedence, and the teleo-typified generic names be repressed; otherwise their names would compete. Exceptions are thus treated similarly in mechanisms 2 and 3. Exceptions will have to be approved and listed. If priority (mechanism 1) were chosen, exceptions could still be treated by invoking conservation.

The case of *Botrytis cinerea* and *Botryotinia fuckeliana* can illustrate mechanisms 2 and 3: In mechanism 2, **option A,** the epithet *fuckeliana* is protected and *cinerea* repressed, the generic name *Botryotinia* is protected and *Botrytis* is repressed. In mechanism 3, **option A,** *Botryotinia* takes precedence and *Botrytis* is restricted to anamorphic species. The correct name would be *Botryotinia fuckeliana.* In mechanism 2 and 3, **option B,** if selected as exception, *cinerea* can be protected against *fuckeliana* and *Botrytis* protected against the repressed *Botryotinia.* The name will be *Botrytis cinerea* with holomorphic application. The genus *Botrytis* with holomorphic application will then accommodate both teleo- and ana-typified species.

Prerequisite: To evaluate the value of each mechanism and either option (without or with exceptions) for the greatest nomenclatural stability while removing dual nomenclature, we need a full database of the pleomorphic and the non-pleomorphic species and genera.

THE SECOND GOAL

The conversion of the anatomical system into a unique botanical system of nomenclature concerns particularly non-pleomorphic anamorphic fungi or deuteromycetes. The application of names should **no longer be linked to the kind of morph** present in the type and in any case it should be holomorphic. Anatomical typification must be replaced by botanical typification.

This extension of the type application of anamorph names from anamorphic to holomorphic can be made according to five different levels of extension, either at generic rank or at specific and generic ranks, and only until a certain date D, or until and after date D (Fig. 1).

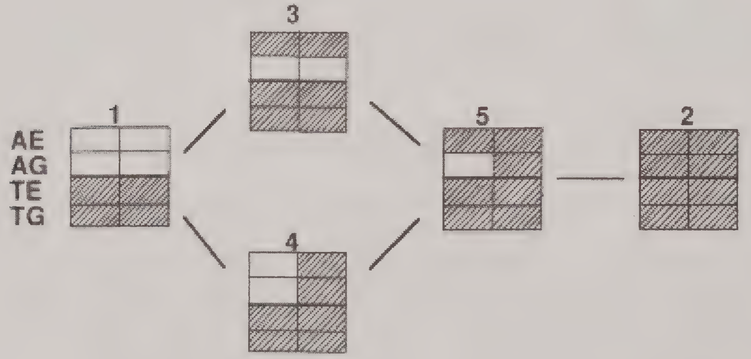

Fig. 1. The five levels of extension of holomorphic application to ana-typified epithets and generic names (AE and AG), TE and TG standing for teleo-typified epithets and generic names. The central vertical lines represent the date D on a horizontal time axis on which integration is enacted. White blocks represent anamorphic application of names, hatched blocks holomorphic application.

Level 1 retains the anatomical, restrictedly anamorphic typification of the epithets and generic names of anamorphic fungi, as presently ruled by Art. 59, and does not allow their integration in the botanical system. On the contrary, level 2, extending holomorphic application of names to ana-typified epithets and generic names retroactively, makes their integration possible. Levels 3 to 5 entail partial extension and maintain either anamorphic application of ana-typified epithets and generic names, under Art. 59, until the date D (level 4), of all present and future ana-typified generic names (level 3) or only of those existing before D (level 5). It is clear that the levels 3, 4 or 5 of extension retain the anatomical typification of names of some taxa, while the names of other existing and future taxa will be botanically typified. By still mixing two systems of nomenclature, they are not better than the present situation (level 1) and do not reach a real integration.

Combinations of the mechanisms for the elimination of alternate names of pleomorphic fungi and the extension of holomorphic application of anamorphic names are the basis of possible procedures of integration of the higher fungi into a botanical system.

Priority (mechanism 1) is only applicable when all names are competing and therefore declared of holomorphic application, as in level 2. Protection/repression (mechanism 2), applied to both epithets and generic names of pleomorphic fungi, but also the combination protection/repression of epithets and precedence/restriction of generic names (mechanism 3) can be applied to any level of extension of holomorphic application of names to generate different procedures. Six selected procedures are fully documented in the text on the web.

Amongst the six envisaged procedures, Procedure 1 based on level 1 and the bipartite mechanism would be the most conservative, with removal of the existing and future dual nomenclature of the pleomorphic fungi, but without any integration.

Procedure 6 based on level 2 and the bipartite mechanism 3, and possibly Procedure 2 based on level 2 and mechanism 2, would be the least complex, the most far-reaching and the least nomenclaturally disrupting, allowing total removal of dual nomenclature and an integrated botanical system of the fungi.

Example: *Botrytis cinerea* anam. of *Botryotinia fuckeliana* and the anamorphic species *Botrytis aclada.*

In Procedure 1 *cinerea* is repressed. *Botryotinia fuckeliana* is the sole name (by protection of the epithet and precedence of the generic name). *Botrytis* is restricted to anamorphic application. The ana-typified *B. aclada* remains in *Botrytis.* If *B. aclada* becomes teleo-connected, *aclada* (anamorphic) will be repressed and replaced by a new epithet in *Botryotinia.*

In Procedure 6 the same as above, but if *B. aclada* becomes teleo-connected, *aclada* (holomorphic) can be combined in *Botryotinia.*

In Procedure 2 *Botrytis* and *cinerea* are repressed. *Botryotinia fuckeliana* is the sole name (by protection). The ana-typified *Botrytis aclada*, when teleo-connected, is transferred as *Botryotinia aclada.*

THE THIRD GOAL

A unified classification is a matter of taxonomy. The integration of anamorph genera and anamorph species into the classification of the Asco- and Basidiomycota needs to be based on affinities either with teleo-connected species or revealed by genetic analyses.

CONCLUSION

Three mechanisms may serve to remove dual nomenclature of the pleomorphic fungi. But before any decision is taken, a fully documented database is needed to evaluate all consequences in view of obtaining name stability.

The status of names of anamorphic fungi can be raised to holomorphic application according to five levels, which will lead to none or partial or total integration of the anamorphic fungi into the Asco- and Basidiomycota.

Acknowledgements

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MYCOTAXON
Instructions to Authors

MYCOTAXON is an international mycological journal devoted to research on the taxonomy and nomenclature of fungi. Publication is open to everyone. Authors are responsible for preparing *camera-ready* computer files or hard copy and obtaining and documenting *peer reviews* of the manuscript made by experts in the field prior to submission. Authors must prepare concise, well-formatted, error-free copy that accurately conveys the author's ideas with an economy of space. The Editor-in-Chief receives camera-ready computer files and/or hard copy of the final manuscript accompanied by a cover letter and complete documentation of the peer reviews.

No page charges are incurred for papers with 64 or fewer pages and one or fewer photographic halftone plates per 10 pages.

THESE INSTRUCTIONS WERE UPDATED **OCTOBER 2003.**

OVERVIEW

- I. Determining what is suitable for publication in *Mycotaxon*
- II. Preparing the first draft
- III. Preparing camera-ready illustrations
- IV. Obtaining peer reviews and revising reviewed manuscripts
- V. Avoiding automatic manuscript rejection
- VI. Submission process: required pre-submission review & final submission
- VII. Obtaining reprints and/or PDF files of the published paper
- VIII. Final author checklist

I. DETERMINING WHAT IS SUITABLE FOR PUBLICATION IN *MYCOTAXON*

Mycotaxon is **restricted to papers on the taxonomy and nomenclature of fungi.** We intend this broadly to include monographic works, reviews of taxonomic groups and/or taxonomic criteria, arguments dealing with specific nomenclatural problems, proceedings of symposia on taxonomic or nomenclatural matters, and well-documented floras. Papers that deal with other mycological disciplines (cytology, ecology, genetics, physiology, etc.) should be submitted to another journal unless their *primary focus* is taxonomic. Prospective authors are encouraged to send a draft to the Editor-in-Chief for consultation regarding suitability of their manuscripts for publication in the journal.

Articles may be of any length. A maximum of 64 pages per sole/senior author is permitted free of charge during any one year. ($18US per page will be charged for each page in excess of 64 pages). Similarly, authors are granted one halftone photographic plate for every 10 manuscript pages, so that 11-20 pages qualify for 2 halftone plates, 21-30 pages qualify for 3 halftone plates, and so on. Authors who wish to publish papers with halftones in excess of this allowance will be charged $18US per extra plate. A plate may contain one or more images but is always accompanied by only one legend. Line drawings are not considered half-tone images and are counted as regular pages in assessing page charges.

ABOUT CHECKLISTS: Until 2003, *Mycotaxon* published annotated regional checklists of fungi. These often provided the first comprehensive records of fungi from under-explored areas. Because web-based documents offer a searchable interface and permit rapid integration of new information, the editorial board has now decided that such checklists are better presented online. Beginning in 2004, *Mycotaxon* will no longer publish regional fungal inventories in their entirety. Instead, the editorial office asks that authors post checklists on the Internet and submit to *Mycotaxon* short (1-4 page) papers summarizing taxa, range and distributions, habitats, and/or references covered and listing URLs to the checklist sites. *Mycotaxon* will post links to the websites summarized in such papers on a special checklists webpage on <www.mycotaxon.com/authors/weblists.html>. *Mycotaxon* will also post PDF files of checklists formatted by authors who do not maintain their own websites.

Checklist authors are *strongly* encouraged to cite references used to identify the taxa in their research. Checklists and summaries, which will follow the same editorial procedures as regular manuscripts, should be submitted together to the *Mycotaxon* Editor-in-Chief after peer review. After receiving editorial approval, authors wishing to post their checklists on the *Mycotaxon* website should contact the Business manager <info@mycotaxon.com> who will supervise placing the PDF files on the webpage and assess a one-time fee of $25. There will be an additional $10 charge for each revision posted on our website with each new version prominently displaying its most recent revision date.

II. PREPARING THE FIRST DRAFT

Articles may be written in either English or French. Authors submitting copy in English should apply a uniform spelling and grammatical convention (American or British) throughout a manuscript. Precise adherence to all formatting rules (see below) is *required*. Papers should be prepared for publication prior to peer review.

Authors are **urged** to prepare and submit **computer-generated** manuscripts using word-processing applications (*MSWord®, Corel WordPerfect®*). *Mycotaxon* also encourages use of publishing applications (*Adobe Pagemaker®, Quark Express®*) where authors can easily combine text with illustrations in one document. Sheridan Press, now responsible for printing *Mycotaxon,* provides a PDF booklet <www.sheridanpress.com/PDF_docs/DigiArt_WP.pdf> that fully explains how to prepare illustrations for use in documents sent for printing. Web-users may also submit up to 3 digital TIFF files to "Digital Expert" <http://www.sheridanpress.com/PDF_docs/DigiArt_WP.pdf> for diagnosis of potential problems prior to submission. Although peer-reviewers must review both text and illustrations, figures need not be integrated into a draft manuscript until after peer-review. Use of standard word-processing applications during this initial phase may be necessary; authors planning to use PDF files, *Pagemaker®*, or other expensive publishing applications should inquire as to the availability of a computer program to peer-reviewers before preparing reviewer copy. Authors are requested **not** to submit PDF files to the editorial office, however, as the Editor must place the *Mycotaxon* header on the title page before sending the fully formatted manuscript to Sheridan Press.

Hard-copy submissions are permitted, but authors should be aware that manuscript processing for hard copy is longer than for computer-formatted copy.

Mycotaxon no longer will reduce over-sized manuscripts. Authors are now **required** to prepare text at the same size as it will appear in the final copy, that is, at 100% or full-scale. Authors are also *strongly* urged to format all illustration materials (including graphs, photographs, and line drawings) at 100%.

FINAL COPY MUST CONFORM TO THE FOLLOWING SPECIFICATIONS

A. Page dimensions and margins Margins should be set so as to produce an 11 cm x 17.5 cm print area on the *Mycotaxon*-sized 15.2 x 22.8 cm [6" x 9"] page. Extra space must be allowed at the top of the first (title) page to permit the Editor to insert the *Mycotaxon* header prior to publication. When setting up a page in a word-processing application, computer users should enter a custom size of 15.2 x 22.8 cm and then set the following margins:

Top margin, *Page 1* (Title Page) —> **4 cm**
Top margin, *Pages 2 and following*—> **2.3 cm**
Side margins —> 2.1 cm
Bottom margin —> 3.0 cm

B. Font faces, sizes, and styles Standard elements of an article are the title, author address information, abstract, keywords, main text, figure legends, acknowledgements, and literature cited. A choice of two serif fonts — **Times, Times New Roman (TNR)** — and two sans serif fonts — **Helvetica, Arial** — is offered. (Authors wishing to use other fonts should check with the Editor before formatting their manuscripts.) Except for occasional line breaks between sections, all text is to be single-spaced. Text formatted with the leading font set one point higher than the text font is permitted; text formatted with 1 1/2 spaces between lines is *not* acceptable.

SECTION	FONT	FONT SIZE	FONT STYLE
Main Title	Helvetica/Arial	11–12 pt	**Bold** & ***Bold Italic***
Authors	Helvetica/Arial[1]	10–11 pt	Regular or LARGE & SMALL CAPS
Author Address	Times/TNR	9–10 pt	Plain or *Italic*
Abstract & Keywords[2]	Times/TNR	7–8 pt	Plain (*Italic for Latin Names*)
Subheadings	Helvetica/Arial[1]	10 pt	**Bold**
Main Text	Times/TNR	9–10 pt	Plain
Subordinated Text[3]	Times/TNR	7–8 pt	Plain (*Italic for Latin Names*)

[1] **Optional:** Author and Subheadings in Times/TNR
[2] **Abstract & Keywords** are best placed on a shorter ~10cm wide line & centered on the page.
[3] **Subordinated text** includes Latin diagnoses, Specimens examined, Figure legends, Acknowledgments, References cited.

C. Main title The main title should be centered on the line and placed in **bold face** (preferably Helvetica 12-point font) with Latin scientific names in ***bold italics***. Latin names of supra-generic taxa may be either in **bold** or ***bold italic.*** *No longer* format titles in upper case: use instead "sentence case" in which only the first word and proper nouns are capitalized. Titles should be concise, yet informative enough to interest readers. Authors should include names of significant taxa but *not* the names of authorities (author citations). (Titles containing author citations will be **automatically rejected** and returned for reformatting unless the author justifies why an authority is necessary to the title in the cover letter.) List the name of a genus in full only once, but otherwise avoid abbreviations. Use arabic, rather than roman, numerals. Never end a title with a period, unless the final word is an abbreviation (e.g., "sp. nov."). A sample of a properly formatted title follows:

Studies in *Agaricales* 3: *Phaeocollybia phaeogaleroides* and
***P. rifflipes,* new western North American species**

D. Author address information List names (with all necessary diacritical markings) and mailing addresses for all authors. E-mail addresses (in lower case and without diacritical markings) are **required** for the senior or corresponding author and recommended for junior authors.

E. Abstract An abstract is *required* for **all** articles. Compose a paragraph (or sentence or two for 1-4 page papers) that summarizes the paper and is meaningful when read alone and apart from the remainder of the paper. Include all new taxa, new combinations, and conclusions. Always prepare one abstract in English. For longer articles, one or two additional abstracts in other languages may be added. Abstracts should be informative but brief, usually *no more* than 15 printed lines long. Omit author citations unless necessary to differentiate homonyms. Abstracts that do not meet these criteria will be returned to the authors for correction.

F. Keywords Authors are *encouraged* to insert a heading for keywords followed by a list of *up to 5* such keywords for use by abstracting services. Do not repeat terms already used in the title or abstract. Separate keywords or keyword phrases by commas, and do not capitalize keywords unless the word or phrase is a proper noun. End this section without a period.

G. Main text *Briefly* introduce your subject, citing significant background literature. Document your own observations concisely and stress new discoveries Comply with the current *International Code of Botanical Nomenclature* when describing new taxa or proposing new combinations. To minimize confusion when discussing generic epithets beginning with the same initial letter, we strongly recommend that you abbreviate one using the first two letters of the epithet throughout the paper (*e.g., C.* for *Cantharellus* and *Cr.* for *Craterellus).* Names of authorities should appear only once, in a separate table or in the text near where the names are first mentioned or (if new) formally proposed. For authorities of taxa use the abbreviations cited by IPNI in the International Plant Names Index <www.ipni.org/ipni/query_author.html>, the Harvard University Herbaria database <brimsa.huh.harvard.edu/cms-wb/botanist_index.html>, or CABI's *Index Fungorum* <www.indexfungorum.org/Names/Names.asp>. *Authors of Plant Names* by Brummit & Powell (1992) and *Authors of Fungal Names* by Kirk & Amsell (1992) may also be consulted. For acceptable herbarium & collections acronyms, consult *Index Herbariorum* (Holmgren et al. 1990) <www.nybg.org/bsci/ih/searchih.html>. Authors describing new taxa are expected to cite relevant acronyms and registration numbers to facilitate retrieval of the material/data by readers and to deposit (i) type specimens in an official, public herbarium, (ii) ex-type strains in a public culture collection, and/or (iii) sequence data in GenBank.

H. Literature cited Include all references cited in the text, ensuring that all references in the "Literature Cited" section are also found in the main text. Standardize abbreviations of journal and other periodical titles. See **BPH** *(Botanico-Periodico-Huntianum,* Lawrence & al. eds., 1968), **BPH/S** *(Botanico-Periodico-Huntianum/Supplementum* Bridson ed., 1991), **TL2** (*Taxonomic Literature*, Stafleu & Cowan, 1976-1988), and the *Supplements to Taxonomic Literature* (Stafleu & Mennenga, 1992-1995) for recommended abbreviations. Authors are required to **single-space** entries (that is, do *not* separate citations by a blank line) and to follow a consistent citation style throughout. Placing references in *7-8 pt font* and using *hanging* indents is **strongly** advised. *Recommended* as a space-saving measure are (i) replacing given names (surnames) by initials, (ii) eliminating periods after initials, (iii) universally placing last names before initials, and (iv) using commas *only* to separate listed authors (no "&" or "and").

EXAMPLES

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi. CAB International, Surrey UK.

Senior AA, Junior BB. 1997. Title with *Latin name* here. Mycotaxon 56: 254-272. (See **sample manuscript** for further suggestions.)

III. PREPARING CAMERA-READY ILLUSTRATIONS

A. Illustration size and placement All articles published in *Mycotaxon* begin on an **odd**-numbered (right-hand) page, so plan size and placement of illustrations within the text accordingly. When possible, insert an illustration within or facing the page of text where the illustration is first mentioned (preferably on a right-hand page). Submit illustrations at the **same sizes** that they will appear in the final publication. (Authors who cannot reduce their illustrations to publication size should contact the Editor-in-Chief for advice or permission to submit oversized copy.) Also **group** figures to facilitate species comparisons and keep page numbers to a minimum. Place figure legend/s on the same page as (preferred) or on the page *facing* the illustration.

B. Line drawings may be submitted as digital images imported from scanned originals or as reduced copies of original artwork. Drawings that have been produced digitally using vector information can be submitted as 600dpi or 1200dpi **EPS** postscript files, which describe a single page and thus contain any combination of text, graphics, and images.

1. Hard copy Because line drawings convey only black and white information, they are reproduced by the same process as the main text, enabling drawings and text to be printed together. Carefully place line drawings onto existing text pages with captions printed directly below or to the side of each drawing. With care, authors generally can reduce oversized drawings using the reduction feature on photocopiers without decreasing image quality and assemble an attractive arrangement from the cut & paste illustrations and captions.

2. Digital files Authors equipped with computer scanners and applications such as *Adobe Photoshop*® & *Pagemaker*® and *QuarkXpress*® can speedily convert line drawings to 300dpi TIFF or .jpg files for insertion directly into the document. Adjustments to the image — including insertion of scales, numbers, and arrows — are easily handled in such applications. See guidelines for preparation of digital photographs *(C2 below)* for further suggestions.

C. Black and white photographs *Mycotaxon* prints only black & white photographs, but authors may submit color hard copy photos if necessary. Both black & white and color film-based (non-digital) photographs have a "continuous tone" requiring transformation into a separate *halftone image* before they can be printed in a magazine or on a computer printer. A halftone image consists of many variously sized and spaced dots, which are easily seen using a hand lens. Black & white halftones consist only of black dots, but all color halftones contain different sized dots of several colors (usually three plus black) spaced to achieve the desired color balance. Authors using digital or computer-generated images must **not** print such images themselves as "print-ready hard copy" but instead submit high-resolution TIFF computer files with their documents to the Editor. The TIFF files **must** be formatted in *black & white* to allow the press to format the photographs properly before printing. When grouping photographs into **plates**, authors should ensure that the contrast among individual photographs is not too great before converting the plate to a TIFF file. *Mycotaxon* will accept photographs or plates that are shorter than page height, but the plates generally should span the **full-page** width of 11 cm.

1. Hard copy photographs When submitting **hard copy** (or electronic text + illustration hard copy) photographs or plates made by combining photographs, mount each plate onto a separate sheet of heavy white paper or matte board, allowing sufficient margins around the photograph for editorial markings and printer's directions. Write the (senior) author's name on the reverse of *each* plate, and place no text except for necessary numbering or lettering, arrows, and other annotations on the halftone plate faces. Print figure legends and other text separately as part of the main text. Sheridan Press will insert the finished photographic halftone plates into the appropriate camera-ready text page(s). Whenever a plate fills an entire page and leaves no room for a caption, place the legend at the bottom of the text page *facing* the plate, separating the caption from the main text by a thin line. Do not border or edge photographs and plates with a line.

2. Digital files Authors who submit **digital photographs** may insert all illustrations and figures into the document utilizing options provided by a publishing application such as *Pagemaker* or *QuarkXpress,* and a software program such as *Adobe Photoshop®* will allow preparation of digital photographic **TIFF** files. (Low-resolution files — such as jpgs or bitmaps —are not suitable for print publication of half-tone photographs.) Configure TIFF image files by selecting a *black and white* setting and typing in dimensions that match the *exact final printed size* when printed at *300-600 dpi* (dots per inch). Label each TIFF file with the (senior) author's name and plate number (e.g., *name_pl#.tif*) **and** mark the location of each on the appropriate blank manuscript areas (e.g., *TIFF plate #*). When using a publishing application such as *Adobe Pagemaker®,* you must submit both your TIFF files *and* the copy-ready document file. **Before** formatting your document, please **check** with the Editor-in-Chief to verify that the *Mycotaxon* press recognizes your publication program.

IV. OBTAINING PEER REVIEWS AND REVISING REVIEWED MANUSCRIPTS

Mycotaxon is unusual among scientific journals in that it is the responsibility of the authors to obtain peer reviews of their papers before submitting the manuscript. Send a copy of your fully formatted manuscript to **two** scientists in your field of study but *outside your home institution* for critical comment. If you are uncertain whom to approach for review of a manuscript, you are encouraged to send a summary or draft to the Editor-in-Chief, who will then suggest several researchers in the appropriate field.

It is ***your*** responsibility to provide each peer reviewer with the 2001 *Reviewer's Guidelines for Mycotaxon Articles* (*Mycotaxon* 78: 539-540) or advise the reviewer that they can be downloaded from the journal's website. It is also ***your*** responsibility to provide each reviewer with all figures (photographs, line-drawings, graphs, tables, etc.) and formatted text.

You are expected to revise the manuscript in response to reviewer comments before final submission and to address discrepancies in your cover letter should you disagree with a reviewer. Be prepared to ***revise*** your pages when reviewer suggestions alter original page endings. *Double check* that changes have not resulted in any “widows” or “orphans” (single lines at the top or bottom of a page). Peer reviewer comments and cover letters *must* accompany manuscripts submitted to the Editor-in-Chief, who will acknowledge all peer reviewers in the closing pages of each volume.

V. AVOIDING AUTOMATIC REJECTION OF A MANUSCRIPT

In our ongoing effort to improve the professional appearance of the journal we are enforcing the following criteria that may result in **automatic rejection** of submitted manuscripts. Automatically rejected papers may be resubmitted after authors reformat the papers to meet these criteria. The points below must be carefully followed to ensure that your paper is not rejected on *formatting* grounds:

A. Employ single-spacing throughout the paper: Camera-ready documents **must** be single-spaced throughout. Main text formatted with 1 1/2 spaces between lines will be **rejected.** Text formatted with the **line spacing** set **one** point higher than the selected text font is acceptable and will provide sufficient separation between text lines of text (In MSWord®, this paragraph formatting is achieved by selecting the “exactly” option and typing in a font size one point higher than the text font size — e.g., “exactly 11pt” for text formatted in 10pt font.) Single blank lines may be used to separate paragraphs but should **not** be used to separate entries in the literature-cited section. A typical full text page should contain 40–48 lines; pages with subordinated text sections formatted to 7- or 8-point fonts will contain more.

B. Select the proper font faces and sizes: Format **titles** in sentence case in Helvetica or Arial [optionally Times or Times New Roman (TNR)] 11– or 12–point bold font, placing Latin scientific names in bold italics. Stand-alone section headers should be in Helvetica or Arial (Times/TNR again optional) 10- or 11–point boldface font. **Main Text** must be in Times/TNR 9- or 10–point fonts. *Mycotaxon* recommends Times/TNR 7- or 8–point font for **subordinated materials** (abstract, Latin diagnoses, specimens examined, figure legends, acknowledgments, and literature cited). Use of other fonts and sizes without prior editorial approval is reason for automatic rejection.

C. Select the proper font style: Titles **no longer** are to be formatted in upper case; authors are required to place titles in "sentence case", in which only first word and proper nouns are capitalized. Use **bold** for names of all new taxa of all ranks at the point in the text where they are formally described. Latin names of taxa at generic rank and below should otherwise be in *italics*. Names of taxa above generic rank may be formatted in either italic or normal typeface at the author's discretion. Occasional use of bold face for subheadings within the text or for names of taxa within keys may be pleasing. You can also occasionally emphasize text using UPPERCASE or LARGE AND SMALL CAPS. (See the **sample manuscript** for examples of font styles in technical descriptions and specimens examined.)

D. Never use underlining: Although underlining is an easy option when using a computer, never underline when preparing camera-ready manuscripts. Underlining, which makes text difficult to read in single-spaced formatted documents, is *never* used in printed publications. To achieve emphasis use *italic*, **bold**, or (exceptionally) ***bold italic*** typeface.

Please be aware that some word-processing applications (such as MSWord®) are set to format email addresses or website URLs automatically in **hyperlink format**, which usually produces the address in underlined, often **blue underlined**, font. Such formatting is not acceptable for *Mycotaxon*. To ensure that such hyperlinks do not appear in the final paper, authors should **turn off** the automatic hyperlink feature **before** generating their manuscript. (Macintosh users can turn off this feature by (i) selecting "AutoCorrect" on the Tools menu, (ii) clicking on the "AutoFormat As You Type" tab, (iii) under "Replace As You Type", remove the check from the "Internet paths with Hyperlink" check box by selecting (clicking on) the check box. Consult your computer manuals for guidance on other platforms or in other applications.)

E. Headings must not occur alone as the bottom line of a page: Prevent "orphan" headings by arranging them so that there are at least two lines below a heading on the bottom of a page whenever possible. Also do **not** end any heading with a period.

F. Prevent punctuation problems: Commas, periods, and other punctuation should be in the same font style as the words immediately preceding them. Thus commas following italicized words should also be in *italics,* in bold when the preceding words are in **bold,** and in bold italic when the immediately preceding words are in ***bold italic.*** The ONLY exception is with paired marks (parentheses, square brackets, quotation marks, single quotation marks), where the closing mark takes the same font style as the preceding open mark. With the exception of the sanctioning colon (e.g., Fr. : Fr.), no spaces should come between a punctuation mark and the text preceding it. Likewise, no space should come between an initial paired mark, such as an open parenthesis, and the following text. Only **one** space should separate sentences following a period in computer formatted manuscripts.

G. The micron symbol: µ can be generated in most computer text fonts by using special keystrokes (*e.g.*, "option+m" on a Macintosh or "insert symbol" on a PC). Do *not* import a micron mark from a font different from the one you are using (such as Greek). PC-users who must select µ from "Symbols" should place the symbol in the same-sized font as the surrounding text.

H. Learn the difference between a hyphen, an en-dash and an em-dash. A *hyphen* will break at a line end and should be used whenever the author needs to hyphenate a word manually to ensure well-populated lines in justified text. An *en* dash (generated on

Macintosh computers with "option+dash") is a longer hyphen that does not break at a line end and is frequently used for minus signs in mathematical notation or for "to" in such constructions as "8–10". (In the latter case, an *en* dash prevents the "8-" from occurring on one line and the "10" on the next.) No spaces should come between an *en* dash and the elements it connects. An *em* dash ("shift+option+dash" on Macintosh computers) is the longest and — generally — is reserved to set aside parenthetical observations. The three look like this: hyphen: -, en-dash: –, and em-dash: —. On a PC the keystrokes are different, but the concept is the same.

I. Do not print headers or page numbers on the camera-ready copy. You may wish to use author names, page number headers, and line numbers during the pre-submission peer review process. Remember to **remove** all headers, footers and line numbers before submitting final computer-formatted copy. On submitted hard copy, add the senior author's name and page numbers using a soft pencil on the back (top left) of each page.

J. Make a final check for spelling and grammatical errors. It is the responsibility of the author to proofread the manuscript for spelling, typographic, and grammatical errors. Ask someone fluent in English (or French) to proofread the paper if you are not. Special attention should be given to Latin diagnoses: authors are encouraged to keep these short by citing only key characters separating a proposed taxon from similar taxa, and shorter diagnoses are likely to contain fewer errors than more elaborate and complicated descriptions. Two common spelling errors are (i) mistakes in the author's own name and address and (ii) spelling names of taxa one way in the text and another way in an illustration caption.

K. Print camera-ready manuscript. Hard-copy submissions should be centered within an invisible 11 x 17.5 cm "frame" on US standard letter (8.5" x 11") or A4 paper. Document settings usually can be customized in computer-generated files within the application. In the MSWord® print set-up menu, for example, authors would enter "15.2 cm x 22.8 cm" (6 in. x 9 in.) into the "custom" size box and then set margins at 4.0 cm (top, title page), 2.3 cm (top, all other pages), 2.1 cm (side), and 3.0 cm (bottom).

VI. SUBMISSION PROCESS (Post peer-review)

A. Send pre-submission materials to the Editor-in-Chief: Pre-approval of title, abstracts, and keywords by the *Mycotaxon* Editor-in-Chief is **required** and of an entire computerized manuscript *strongly* encouraged. Before submitting a final manuscript, **E-mail** the above three required features as a formatted attachment to <editor@mycotaxon.com>, and include "For Mycotaxon pre-approval" in the subject header. This will help diagnose problems in the text that historically have most often resulted in **automatic rejection**.

B. Double-check grammar, spelling, and overall formatting We *strongly* suggest that you use your word-processing program's grammar and spelling checker if it has one.

C. Submit manuscripts and supporting documents

After pre-approval of the title, abstracts, and keywords by the Editor-in-Chief, the author may formally submit the manuscript and supporting documents.

The **manuscript** consists of

- **(i)** computer-generated camera-ready files on CDs (formatted for both Macintosh and PC), zip disks (Macintosh formatted), or PC formatted floppies;
- **(ii)** original camera-ready hard copy with illustrations, printed only on one side of the paper and with author's name and page numbers on the back top left of each text page and with name and plate number on the back of each illustration; and
- **(iii)** a photocopy of the camera-ready text hard copy for the Index Editor (no illustrations needed)

The manuscript must be accompanied by the following **supporting documents**:

(iv) a cover letter with the following information:
  a. title of the article,
  b. number of pages,
  c. the senior and/or corresponding author's mailing address
  d. e-mail addresses and/or fax numbers for all authors
  e. placement of accents or diacritical marks associated with names of the authors
  f. names, institutional affiliations, and E-mail addresses of the peer reviewers,
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ERRATA

VOLUME EIGHTY-FIVE

Page 91, Abstract, line 5, page 91, 3rd line from bottom, page 490, line 11, page 517, col. 1	for	*Pestalotiopsis alöes*	read	*Pestalotiopsis aloës*
Page 517, col. 2	for	*Pestalotiopsis ALÖES*	read	*Pestalotiopsis ALOËS*

VOLUME EIGHTY-SEVEN

Cover 2, line 13, page iv, line 8
for *Armin Tkalcec & Armin Mesic* read *Armin Mešić & Zdenko Tkalčec*

VOLUME EIGHTY-SEVEN (& 85, 86)

Page [ii] for *CAROL H. SHEARER, Chicago,* read *CAROL A. SHEARER, Urbana,*

VOLUME EIGHTY-SEVEN

Page 128 and 129: these two pages were incorrectly numbered and thus in the wrong page order through a printer's error. The two new combinations, *Bauerago commelinae* (Kom.) Denchev, and *Bauerago combensis* (Vánky) Denchev, are, for nomenclatural purposes, to be considered as having been published on page 128. The correct pagination appears in both the list of nomenclatural novelties (page 503) and in the volume index (page 513).

Page 142, line 10	for	*dextrinophila*	read	*dextrinospora*
Page 527, col. 1, line 20	for	*dextrinophila*	read	*dextrinospora*

VOLUME EIGHTY-EIGHT

Page 5, line 28	for	*lacunose*	read	*lacunosa*
Page 22, line 7	for	*eben-bitaricum*	read	*eben-bitarianum*
Page 23, line 12	for	*huguesii*	read	*hughesii*
Page 25, line 3	for	*hexophragmia*	read	*hexaphragmia*
Page 28, lines 9-10	for	*moubascherii*	read	*moubascheri*
Page 29, line 16	for	*Ascochtyella*	read	*Ascochytella*
Page 30, line 22	for	*Stegonosorium*	read	*Stegonosporium*
Page 30, line 44	for	*paleaestina*	read	*palaestina*
Page 33, lines 2-3	for	*sudddiana*	read	*suddiana*
Page 33, line 35	for	*egyptiacus*	read	*aegyptiacus*
Page 38, line 9	for	*puberis*	read	*puberum*
Page 39, line 1	for	*pseudo-heteromorphus*	read	*pseudoheteromorphus*
Page 39, line 7	for	*palestinae*	read	*paleestina*
Page 39, line 32	for	*moubasherii*	read	*moubasheri*
Page 40, line 26	for	*Steganosporium*	read	*Stegonosporium*
Page 40, line 40	for	*intermedium*	read	*intermedia*
Page 40, line 41	for	*sesamicum*	read	*sesamica*
Page 50, line 15	for	*Stigmateae*	read	*Stigmatea*
Page 115, line 43	for	*chorocyanea*	read	*chlorocyanea*
Page 373, line 14	for	*echinosporum*	read	*echinospora*
Page 431, line 5	for	*leucophaum*	read	*leucophaeum*
Page 471, line 11	for	*plombii*	read	*plombi*

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"The book is important for any researcher interested in the systematic relationships, diversity, and distribution of fungi on a global scale." - *New Zealand Journal of Botany* 35: 265-266. 1977.

Higher Fungi of Tropical China, edited by Wen-Ying Zhuang. Mycotaxon, Ltd. 2001. Cloth bound, 485 pp., 26 x 18.5 cm. US$50.00 plus postage. (Please *order direct* from Wen-Ying Zhuang, P.O. Box 2714, Beijing 100080, China, email zhuangwy@sun.im.ac.cn). ISBN 0-930845-13-7.

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Spheriacei Italici. Centuria II, by Giuseppe De Notaris. *Annotated transcription of the unpublished autographic draft,* edited by Antonio Graniti, Laura Zucconi, & Claudio Ciccarone. Mycotaxon, Ltd. 2001. Softbound, 144 pp., illustrated [includes CD showing reproductions of the original manuscript and drawings in JPG-format], 23.5 x 16.5 cm. 65 Euro, plus postage. (Please *order direct* from Accademia Nazionale della Scienze detta dei XL, Via Spallanzani 7, I-00161 Roma, Italy, email: biblioteca@accademiaxl.it, fax +39.06.44250871.) ISBN 0-930845-12-9.

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Volume 89(1) *January-March 2004*

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MYCOTAXON

Greetings from the new Editor-in-Chief

In 1974, Professors Richard P. Korf, as Managing & English Language Editor, and Grégoire L. Hennebert, as Book Review & French Language Editor, introduced a new mycological taxonomic journal to the world. After thirty years, *Mycotaxon* has received international acclaim for its outstanding success in expediting publication of new fungal species while fostering open communication between mycological contributors and expert reviewers. As a satisfied 21-year subscriber and occasional contributor, it is with a mix of pride and trepidation that I assume the editorial duties of the founders and their succeeding Editors-in-chief, Dr. Jean Boise Cargill (1991-1998) and Dr. Pavel Lizon (1998-2003).

From the beginning, all agreed that this most recent transition should be "as seamless as possible." And so it should appear, at least to the subscriber. The journal retains the same name, its cascade of different-hued covers, and a comforting "book" heft and shape that scores of library shelves have been designed to accommodate. The journal will still appear quarterly and still focuses on fungal taxonomy and nomenclature.

Nonetheless, now is the best time to implement changes long desired by the Editorial Board. One innovation is our decision to "web-ify" regional checklists, thereby making them available to more users and providing data that is easily searched by user and more easily updated by author. Dr. Ahmet Asan of Turkey and Dr. Larry Grand and Caroline Vernia of North Carolina — who publish short summaries in *Mycotaxon* 89(1) — become the first to "publish" their complete checklists on what we hope will become one of www.mycotaxon.com's most heavily used webpages.

In an era when most scientific documents are created on the computer, there is little sense in continuing to publish exclusively from print-ready hard copy. The move away from typewriter technology now enables anyone with access to a word-processing program to submit professional appearing manuscripts. But with so many font choices and styles available, there was a need to restrict font choices so as to produce a more pleasingly uniform appearance for our journal. Hence our extensive author guideline revisions published in *Mycotaxon* 88: 515-526, 2003.

Unfortunately, we did not realize until three weeks before press time that our "new" guidelines still offer too many choices for a uniform first page format. Please note our **newest** Author, Address, Abstract, and Key words requirements:

- **AUTHORS**—Times/Times New Roman, 10-point font, boldface, Large & Small Capital, centered on page;
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(continues inside back cover)

MYCOTAXON

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Crepidotus from Mexico: New records and type studies

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Abstract—*Crepidotus albidus*, *C. calolepis*, *C. croceitinctus*, *C. latifolius* (var. *latifolius* and var. *praelatifolius*), and *C. palmarum* are reported from montane broad-leaved forests of the Sierra Madre Oriental of eastern Mexico. *Crepidotus calolepis* and *C. palmarum* have also been collected in a tropical forest south of the Gulf of Mexico, with *C. calolepis* found at additional sites in the country. New data resulting from reexamination of five type collections as well as observations made in fresh material support the taxonomic interpretation of *C. calolepis* var. *heterocystis*, *C. calolepioides* and *C. molliformis* as synonyms of *C. calolepis*, and *C. latisporus* var. *veraecrucis* to be conspecific with *C. palmarum*. *Crepidotus praelatifolius* is supported as a variety of *C. latifolius*. Observations made on samples of some members of the Stirps *Mollis sensu* Singer are discussed. Descriptions, illustrations, and discussions are provided for all taxa.

Keywords—Agaricales, taxonomy, wood inhabiting fungi

Introduction

Although information is available for many representatives of *Crepidotus* (Hesler 1975; Hesler and Smith 1965; Kühner and Romagnesi 1953; Lonati 2000; Pilát 1948, 1949, 1950; Singer 1947, 1973, 1988), it is clear that at present few species are completely documented and consequently better understood taxonomically (Bandala et al. 1999; Bandala and Montoya 2000a & b; Bigelow 1980; Horak 1964; 1977; Horak and Desjardin 2004; Lonati 2000; Krisai-Greilhuber et al. 2002; Luther and Redhead 1981; Nordstein 1990; Ortega and Buendia 1989; Pegler and Young 1972; Pereira 1990; Redhead 1984; Senn-Irlet 1995; Senn-Irlet and De Meijer 1998; Senn-Irlet and Krieglsteiner 1996; Stangl et al. 1991). Perhaps due to relatively simple basidiomes (small, sessile, rarely colored), few macroscopic features have been evaluated which in fact provide reliable taxonomic information into the genus. The taxonomy of *Crepidotus* is practically supported by the information revealed by microscopic morphology. It is also true that after diagnosis not all the taxa have been restudied and documented with new collections or, in many cases, our knowledge of the species depends solely on specimens gathered in the geographic area sampled. The information available in the literature is often limited, and as suggested by Horak and Desjardin (2004), in several cases it represents weak and confusing data for the interpretation of species. Then, there is the possibility that variation of single uncorrelated characters could have been taxonomically overestimated, or, contrarily, that the population has been split mainly when superficially different specimens occurring in separate regions were compared.

During the last three years, simultaneously with our reexamination of herbaria samples (type collections included), we have collected new specimens in Eastern Mexico. The variability shown by Mexican specimens is well represented in different previously described species. Some other materials, however, exhibit a similar macro and microscopic pattern of variation which have been found in collections dealt with in current literature under different taxa. Confronted with the variation seen among the collections and in an effort to determine them, we have firstly been forced to elaborate a morphological species concept in order to help create a reproducible and predictive classification. For the present paper we selected information obtained from new collections of five species previously known in the country. These are reported from several new localities in Mexico which document a greater range of extension. Type studies of *C. calolepis* var. *heterocystis* Singer, *C. calolepioides* Murrill, *C. latifolius* var. *veraecrucis* Singer, *C. molliformis* Singer and *C. praelatifolius* Murrill complemented the information and are also discussed.

Methods employed in the microscopic study of specimens were those previously cited in Bandala et al. (1999) and Bandala and Montoya (2000b), although notation *RM* is now used for designation of the range of mean values of basidiospore length and width in *n* collections, or in the case of a single collection to *n* spores measured (usually 30-35). Color described for basidiomes was compared and coded according to the color chart of Kornerup and Wanscher (1978) (alphanumeric color ranges in brackets). The species are presented alphabetically. Herbaria are abbreviated according to Holmgren et al. (1990).

Taxonomy

A. DESCRIPTIONS AND NOTES OF NEW RECORDS

1. *Creidotus albidus* Ellis & Everh. **Figure 1**

Crepidotus albidus Ellis & Everh., Proc. Acad. Nat. Sc. Phil. p. 322, 1894.
Synonym: *C. citri* Pat., Bull. Soc. Myc. Fr. 18: 172, 1902; *C. levisporus* Singer, Beih. Nova Hedwigia 44: 479, 1973; *C. sublevisporus* Singer, in Singer & Digilio, Lilloa 25: 410, 1951; *C. yungicola* Singer, Beih. Nova Hedwigia 44: 480, 1973.

Most relevant data obtained in collections studied are: **pileus** (0.5-) 2-10 mm broad, white, finely tomentose hairy, semicircular, somewhat reniform by the presence of an incision in the rear portion, convex to plane, more or less campanulate or ungulated in young stages, margin striate to weakly sulcate, in some slightly crenulate. **Lamellae** whitish or white with pinkish shades, brownish with edge. **Basidiospores** 6.4-7.2 x 4.8-5.6 μm, *RM* = 6.7-6.8 x 5.1-5.3 μm, *Q* = 1.29-1.33, broadly ellipsoid, smooth, brown to yellowish-brown, thick-walled (up to 0.5 μm thick). **Cheilocystidia** (12-) 14-29 x 2-5 (-6) μm, narrowly lageniform to subcylindric, markedly flexuous and contorted, apex 1.6-2.4 μm wide, hyaline, clampless, often certain kind of incrustations-like granules are scattered among these elements. **Clamp Connections** often present in the base of hymenial elements. For more macro- and microscopic details see Bandala and Montoya (2000a) and Krisai-Greilhuber et al. (2002).

Habitat. Subgregarious, on rotten branches, on of them apparently of *Quercus*, in a mesophytic forest.

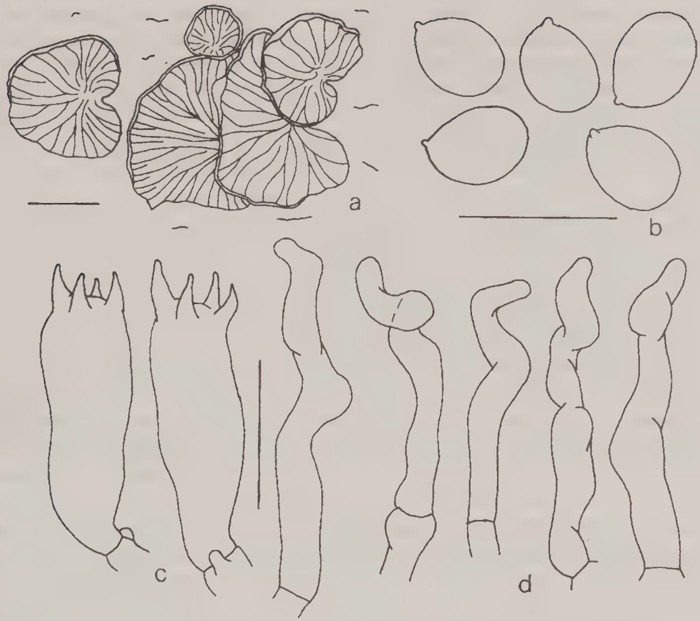

Fig. 1. *Crepidotus albidus*. a: basidiomes; b: basidiospores; c: basidia; d: cheilocystidia (Bandala 3705) (scale bar = 10 μm, except a = 5 mm).

> **SPECIMENS EXAMINED**. MEXICO. PUEBLA: **Chiconcuautla Co.**, San Cristóbal Xochipehuala, 3-IX-2002, *Bandala 3705*, *3707* (XAL).

Remarks. The combination provided by smooth basidiospores, clamps, ungelatinized tissues, and narrowly-lageniform, contorted cheilocystidia, clearly distinguish *C. albidus*. This combination of morphocharacters made it possible to interpret its conspecificity with some South American and Mexican taxa (see synonymy above). After a comparative study between North and South American type collections, Bandala and Montoya (2000a) provided a discussion of the taxonomy of this species, which was recorded from a mesophytic forest near Xalapa, Veracruz (Gulf of Mexico area). For the inventory of *Crepidotus* in Mexico we now add the above records from N Puebla. *Crepidotus albidus* presents in Mexico a scattered but more or less continuous distribution throughout the Sierra Madre Oriental and southwards along the east coast, either in broad-leaved forests (mesophytic and tropical) or reaching mixed associations of *Pinus-Quercus* in the Cofre de Perote Volcano in the central region of Veracruz. Further within the interior of the country the species is known to occur in *Pinus-Quercus* associations from the Nevado de Toluca Volcano (Central Mexico) (Krisai-Greilhuber et al. 2002). The samples known at present reveal that *C. albidus* is a commonly encountered agaric inhabiting woody substrates, having a fragmented distribution along the American continent.

2. ***Crepidotus calolepis*** (Fr.) P. Karst. **Figures 2-4, 10a-b, e-g. Plate 1a-c**

Crepidotus calolepis (Fr.) P. Karst., Bidr. Känn. Finl. Nat. Folk 32: 414,1879.
Basionym: *Agaricus calolepis* Fr., Öfvers. K. Vetensk.-Akad. Förh. 30 (5): 5, 1873.
Synonym: *C. mollis var. calolepis* (Fr.) Pilát, Act. Mus. Nat. Prag. 2B: 74, 1940; *C. mollis subsp. calolepis* (Fr.) Nordstein, Synopsis Fungorum 2: 67, 1990; *C. calolepis var. heterocystis* Singer, Beih. Nova Hedwigia 44: 469, 1973; *C. calolepioides* Murrill, Mycologia 5: 30, 1913; *C. molliformis* Singer, Beih. Nova Hedwigia 44: 441, 1973. For more synonyms see Singer (1973).

Pileus 6-60 (-65) mm wide, when young almost circular to somewhat rounded flabelliform, some more or less reniform, later semicircular, flabelliform or rounded flabelliform, often with an incision at the rear portion, then somewhat reniform, convex, soon plane-convex to applanate, white, yellowish-white or pale yellowish (3A2-4A2), covered with brown, brown-orange or reddish-brown fibrils which vary in size, density and in the pattern of their distribution on pileus surface, then near glabrous, tomentose-fibrillose, densely fibrillose, appressedly fibrillose-scaly or minutely scaly, to the naked eye the pigmented fibrils and the pale ground surface produce a pale yellowish (3A2-4A2), pale yellowish-orange (more or less 4A3-5B3), yellowish-brown, dark yellowish-orange or reddish-brown pileus color (5C6, 5C7-5D6, 5E6-6C7), in those fine fibrillose elements most part of the disc is whitish and pale brown-orange towards the rear portion where the fibrils are relatively abundant, hygrophanous or strongly hygrophanous, this latter more evident when surface is scarcely covered with brown fibrils and pileus is very wet, then in overal appearance whitish to white-grayish with cottony aspect in some areas, not or weakly viscid to the touch; margin initially incurved, faintly striate. **Lamellae** white, whitish, later pale yellowish-brown, greyish-brown to orange-brown, adnate or somewhat sinuate to shortly decurrent, broad or moderately broad, subventricose to ventricose, close to subdistant, with concolorous or pale, smooth to finely fimbriate edges. **Stipe** absent, the pileus is laterally attached, with a narrow or moderately wide point of attachment, often with a short, smooth or minutely tomentose-fibrillose, lateral, somewhat swollen, appressed protuberance (seen from the hymenophore). **Context** white or whitish, pale brownish in old specimens, thin to moderately thick towards center of pileus, fleshy, somewhat elastic. **Odor** none. **Taste** mild.

Basidiospores 7-11 x (5-) 5.5-7 (-7.5) μm, *RM* = 7.9-9.8 x 5.5-6.6 μm, *Q* = 1.31-1.51, ellipsoid, more or less amygdaliform in side view, often weakly tapering towards the apex, some bearing a mucron-like apex or with a faint suprahilar depression, smooth (even under SEM), thick-walled (<1 μm wide), dark yellowish to light or dark yellowish-brown, brown-yellow in mass. **Basidia** 20-30 (-35) x 8-10 μm, tetrasporic, clavate, hyaline, clampless. **Pleurocystidia** none. **Cheilocystidia** (21-) 23-90 (-110) x (3-) 4-10 (-11) μm, narrowly lageniform or sublageniform, often subcylindric or narrowly subutriform, some more or less subclaviform, straight, moderately straight or somewhat flexuous, often slightly curved above, some sinuous, occasionally bearing a thin and moderately long base, rarely with constrictions towards the apex, this latter (2.5-) 3-9 (-10) μm wide, abundant, projected beyond hymenium level, commonly arising below hymenial level but also from the hymenium, forming a dense, often refringent layer on lamella edge, which varies in degree of gelatinization even in the lamellae edges of a same specimen, hyaline, thin-walled, clampless. **Pileipellis** a cutis with cylindric to somewhat ventricose, radially oriented, septate, brownish, yellow-orange, brown-yellow, brown-orange or reddish-brown hyphae (5-) 7-15 (-20) µm wide, coarsely or finely incrusted, with inter or intraparietal incrusting brown pigment, incrustations often producing discontinuous lines more or less transversely or spirally oriented, hyphae forming an interrupted layer, compactly or somewhat loosely arranged, variable in width and markedly pigmented, terminal hyphae undifferentiated, often in prostrated groups or moderately erect, then with a trichodermoid appearance, forming the fibrils or scales of pileus surface, only faintly gelatinized but not as a refringent stratum. **Pileus trama** (in tangential section) differentiated in two layers, one beneath pileipellis, gelatinized, often clearly refringent, commonly wide but variable in width and then sometimes very reduced, composed by more or less filamentous to cylindric, somewhat loosely and radially arranged, thin-walled, colorless hyphae 2-5 (-7) µm wide, just downwards a moderately compact, somewhat interwoven stratum is distinctive where hyphae are cylindric or short and bifurcate forming a puzzle-like structure, hyphae up to 20 µm wide, hyaline, thin-walled, variably gelatinized but not refringent. **Hymenophoral trama** with a mediostratum, subregular to irregular, composed of colorless, thin-walled hyphae 5-15 (-20) µm wide, with gelatinized, commonly refringent laterostrata (subhymenium), these latter varying in the degree of gelatinization, then sometimes are poorly differentiated, weakly divergent in arrangement. **Clamp Connections** absent.

Habitat. Subgregarious, sometimes scattered or solitary, on rotten trunks, rotten branches or decaying wood, some of them of *Pinus* and *Quercus*, fructifying in tropical, mesophytic and conifer forests or mixed associations of *Pinus-Quercus*.

SPECIMENS EXAMINED. **MEXICO**.— **CHIHUAHUA**: **Bocoyna Co**., 10 km NW of Bocoyna, Mesa del Oso, 1-VIII-1992, *Moreno IV-3* (FCME 5668). Km 82 road Creel-Guachochi Laja, 30-VIII-1980, *Pérez-Silva et al. s.n.* (MEXU 16298).— **GUANAJUATO**: **Guanajuato Co**., Sierra de Santa Rosa, Cañada de Llano Largo, 1-VII-1995, *Hernández-Muñoz 607* (FCME 7440). Km 9-11 road Monte de San Nicolás-Santa Rosa de Lima, 29-IX-1995, *Pellicer y Villarruel 408* (FCME 7327).— **JALISCO**: **Ciudad Guzmán Co**., Nevado de Colima slopes, road Las Víboras, El Floripondio, 11-VII-1992, *López 39* (IBUG as *C. mollis*; XAL).**Tala Co**., SE La Primavera, Instituto de Madera, Celulosa y Papel, 22-VI-1990, *Guzmán-Dávalos 5140* (IBUG as *C. mollis*; XAL).— **MICHOACÁN**: **Cd. Hidalgo Co**., Loz Azufres, Cañada de Agua Azul, 26-VII-1987, *Bulnes s.n.* (FCME 14190).— **MORELOS**: NW Tepoztlán, 27-VI-1969, *Singer M8239; M8256* (F, both as *C. calolepis* var. *heterocystis*); *M8203* (F as *C. fraxinicola*). Km 4 road La Pera-Oaxtepec, 3-VII-1976, *Pérez-Silva s.n.* (MEXU 10870).— **PUEBLA**: **Zihuateutla Co**., Lagunillas, 9-VIII-2001, *Bandala 3410* (XAL).— **VERACRUZ**: 7 km S Montepio, Estación Biológica de Los Tuxtlas, 19-VI-1969, *Singer M 8029* (F, **Holotype** of *C. calolepis* var. *heterocystis*). Xalapa, Cerro Macuiltepetl, 13-VI-1995, *Bandala 2751*; km 2.5 old road Xalapa-Coatepec, Jardín Botánico Fco. J. Clavijero, 3-VI-1991, *Tapia 577*. Xalapa, Los Berros Park, 5-VI-1986, *Anell 365* (all at XAL).

ADDITIONAL SPECIMENS EXAMINED. **AUSTRIA**.— NW Kahlenberg, 10-VIII-1960, *Singer C211* (MICH, as *C. ralfsii*). **SPAIN**.— **CUENCA**: Hoz de Beteta, March 1975, *Tellería & Moreno s.n.* (AH 478).— **MADRID**: Rascafría, 3-V-1996, *Bandala 2943* (XAL).— **BARCELONA**: Dos Rius, 8-XI-1981, *Tabares s.n.* (AH 2520-B). **U.S.A**.— **MICHIGAN**: **Cheybogan Co**., Colonial Pt. Hardwoods, Burt Lake, 29-VIII-1957, *Smith 57691* (MICH).— **NEW YORK**: Ithaca, 22-VI-1903, *Kauffmann 66261* (MICH); **Thompkins Co**., Lloyd-Cornell Reserve, Slaterville, 27-VII-1957, *Shaffer 249* (MICH).— **OHIO**: Lane, Aug. 1919, *Beardslee 19072* (MICH).

Remarks. The presence of pigmented fibrils on the pileus surface, among other characters (size of the basidiospores, pileus color) has been used to distinguish *C. calolepis* (Cooke1884-1886; Jahn 1966; Murrill 1917; Pegler 1977; Senn-Irlet 1995; Singer 1973; Watling and Gregory 1989). In the literature the species is often reduced to an infraspecific taxon of *C. mollis* (Schaeff.: Fr.) Staude. Singer (1973), however, clearly recognized the fibrillose or scaly forms related to *C. calolepis,* as separating from the group of species around *C. mollis*, arguing (p. 451) '... I believe we should take Fries' diagnosis at its face value. This is necessary also because it was Fries himself who later distinguished *A. calolepis* —referring to *Agaricus calolepis*— precisely because of the 'beautiful squamules' it shows whereas *A. mollis* does not...'. In a concept combining macro- and microscopic features, Senn-Irlet (1995) came to the same conclusion recognizing two species. In the publication by Singer (1973) gelatinized forms represented by *C. mollis* (Subsect. *Defibulatini* Singer) were cited from different localities in Mexico. Three samples (included above) of *C. calolepis* (identified as var. *heterocystis*) were recorded from the States of Morelos (Central Mexico) and Veracruz (Eastern Mexico). Three additional collections gathered near Mexico City were recently reported by Krisai-Greilhuber et al. (2002). These and present records reveal, therefore, a wide distribution of *C. calolepis* in this country, inhabiting woody substrates either in coniferous forests or in broad-leaved forests.

Among the fresh and herbaria samples studied we noted a wide variation in some macro- (number of pigmented fibrils covering the pileus) and microscopic characters (degree of gelatinization of the context and hymenophoral trama), which deserve to be commented. We agree with Hesler and Smith (1965) in that the pigmented fibrils of the pileus surface can be variable in abundance between one collection and another. Even among the elements of a single sample, the frequency and number of fibrils is variable, hence the pileus surface can appear almost glabrous, fibrillose or finely fibrillose-squamose, being white-yellowish, ochraceous or brownish-orange in overall appearance. This variation seems to depend on the pileus development, also on the particular variation of the specimen sampled, as well as on the weather conditions. As observed also by Krisai-Greilhuber et al. (2002), in wet specimens which often have hygrophanous, whitish to whitish-greyish pileus, to the naked eye the surface is apparently glabrous and then recalls that of members of *C. mollis*. This was also annotated in Singer's (1973) description. Sometimes the fibrils are more abundant and conspicuous forming minute scales, but in other elements the fibrils are fine or reduced to the rear portion of the pileus, or they are scattered towards the margin. When present, however, the fibrils consistently have a characteristic microscopic aspect observable under oil lens: the pileipellis hyphae are decidedly pigmented (brownish-orange, yellowish-brown) and minutely or coarsely incrusted. Pigmented hyphae producing a fibrillose or scaly, colored pileus surface like in members of *C. calolepis* are also found in species of other groups of *Crepidotus* [e.g. *C. crocophyllus* (Berk.) Sacc., *C. rainierensis* Hesler & A.H. Sm.]. This would suggest that the character is maintained in different lineages within the genus and its presence or absence could be interpreted as being of taxonomic significance when distinguishing *C. calolepis* from close relatives. However, among the examined samples we failed to recognize a consistent qualitative or quantitative distinction to support an infraspecific segregation based solely on this feature. Thus, without any other correlated character, this limits us to relate our specimens to any of the varieties considered by Singer (1973).

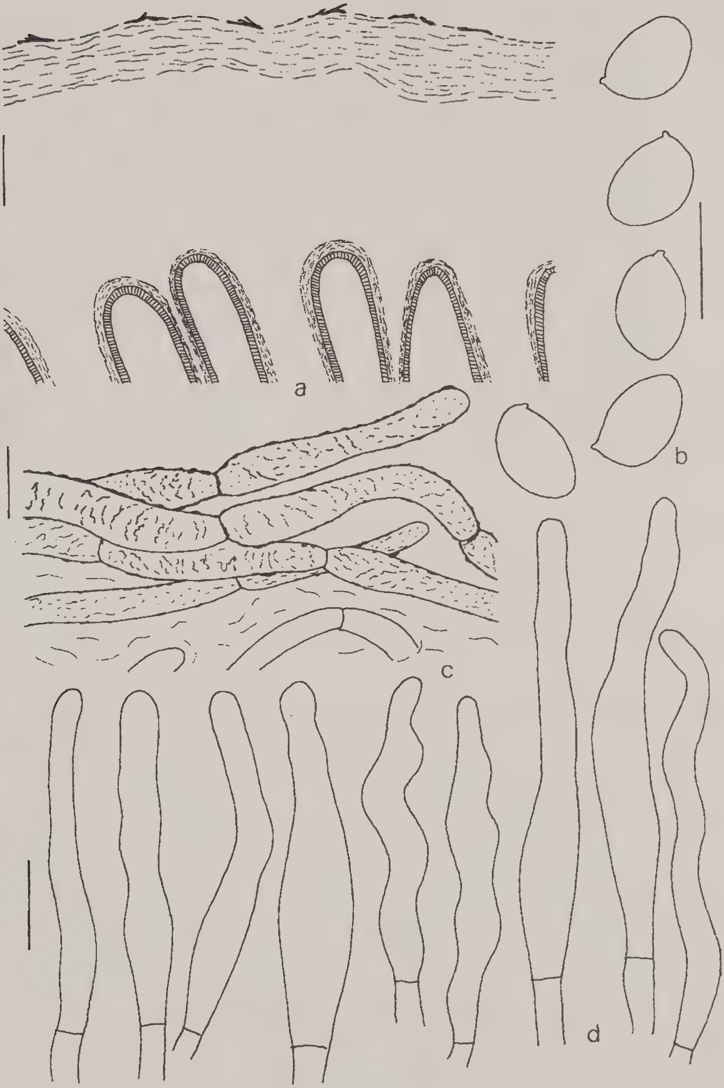

Fig. 2. *Crepidotus calolepis.* a: tangential section of pileus and hymenophore; b: basidiospores; c: pileipellis; d: cheilocystidia (Singer 8203) (scale bar = 10 μm, except a = 168 μm; c = 15 μm).

When introducing a distinction between the members with gelatinized tissues, Singer (1973) made reference to a topographical variation of gelatinized layers, these latter seen in mounted sections of pileus and hymenophore. For an evaluation of such a characteristic all samples gathered by Singer in Mexico and placed in his subsect. *Defibulatini* were examined, as well as selected type collections of species placed by Singer in this latter taxon [e.g. *Crepidotus brasiliensis* Rick, *C. calolepioides*, *C. epigloeus* Singer, *C. fraxinicola* Murrill, *C. tuxtlae* Singer, *C. molliformis*, *C. uber* (Berk. & M.A. Curt.) Sacc., *C. variisporus* Singer, *C. xanthophaeus* Singer] (Bandala 2000; Bandala and Montoya 2000a, 2002). We excluded *Crepidotus levisporus* and allied taxa (= *C. albidus*) which have smooth basidiospores but present clamps and ungelatinized tissues, therefore, they were considered to belong to another taxonomic group (Bandala and Montoya 2000a). In the resulting group of species of subsect. *Defibulatini s.* Singer that include *C. calolepis* and *C. mollis*, we found that the specimens do not have clamps, they bear smooth basidiospores, and invariably present gelatinized tissues and diverticulate hyphae (recalling puzzle-like elements), these latter scattered in the context and hymenophoral trama. Senn-Irlet (1995), Senn-Irlet and De Meijer (1998), and Krisai-Greilhuber *et al.* (2002) indeed described similar features in European and American specimens of species of this group that they studied.

Collections of members of subsect. *Defibulatini s.* Singer selected for study present a certain degree of gelatinization among the tissues, including the cortical layer of pileus. That characteristic is better evaluated since gelatinized, often refringent strata, either in the context or in the hymenophoral trama, are evident in tangential sections (cf. fig. 2a). Such strata presumably were those that Singer (1973) referred to. In the hymenophore the strata are reduced to the subhymenium, i.e. the hymenophoral trama exhibits two refringent, gelatinized laterostrata, and thus the lamella edge commonly presents a relative abundance of gelatine (where the cheilocystidia are immersed). Among lamellae the gelatinized layer of the subhymenium often reaches the lower portion of pileus context, hence appearing as one more stratum of pileus context. However, the most distinctive gelatinized stratum (often refringent) of the pileus context is situated towards the upper portion, just below the pileipellis hyphae. The hyphae of this gelatinized layer are somewhat loosely arranged and more or less periclinally oriented. Except for *C. brasiliensis*, *C. epigloeus*, *C. tuxtlae*, *C. uber* and *C. xanthophaeus* (not treated here) that exhibit only the gelatinized, refringent hymenophore laterostrata, in the context of the specimens examined no more than the upper gelatinized stratum can be recognized. These gelatinized, refringent strata, however, can be variable in width and better developed from one specimen to another, even within a same collection. In some specimens the gelatinized stratum of the context can be notably wide, and then the rest of the context appears reduced, whereas in the hymenophore the laterostrata can be thin and more conspicuous towards the lamella edge. Or on the contrary, the laterostrata can be somewhat wide along the lamella, and the gelatinized layer in the context can be reduced (evidently the specimens of the latter species cited show such variation in the hymenophore). This variation can even be related to the basidiome development, context thickness or to the effect of prevailing weather conditions when the specimens were sampled, and perhaps in some cases also to the process of conservation (drying). Studies on ontogeny are still required for a better understanding of the extent of the morphologic variation of each taxa. Since in the group of specimens examined of *Crepidotus calolepis*

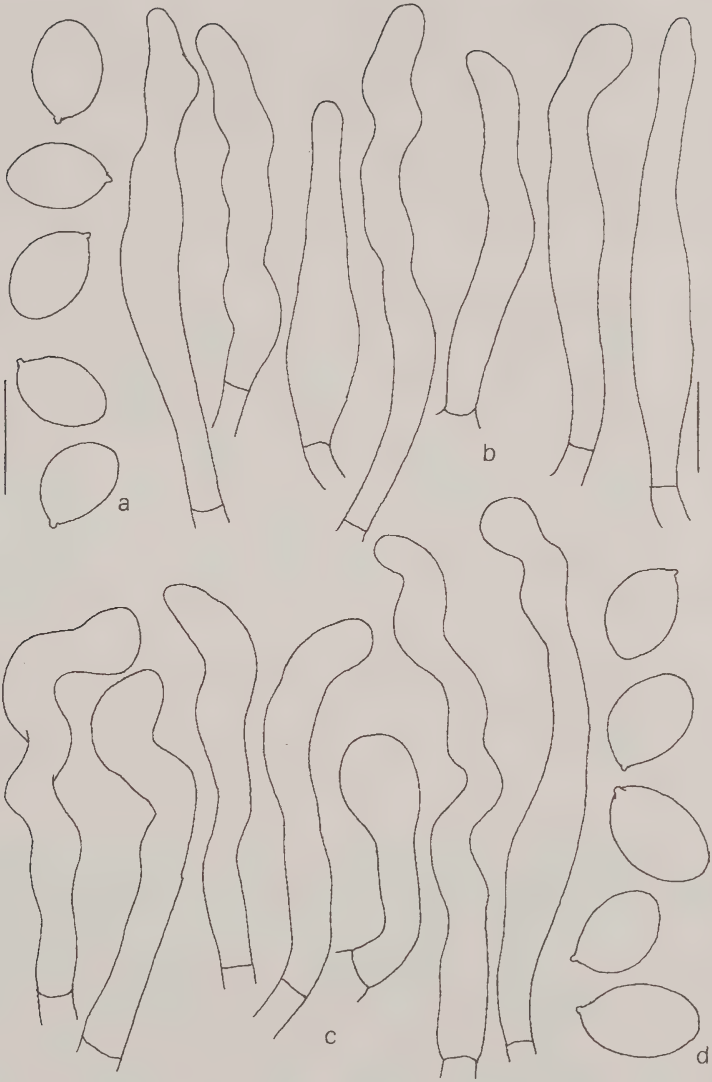

Fig. 3. *Crepidotus calolepis*. a: basidiospores; b: cheilocystidia (Singer 8029); c: cheilocystidia; d: basidiospores (Singer 8256) (scale bar = 10 μm).

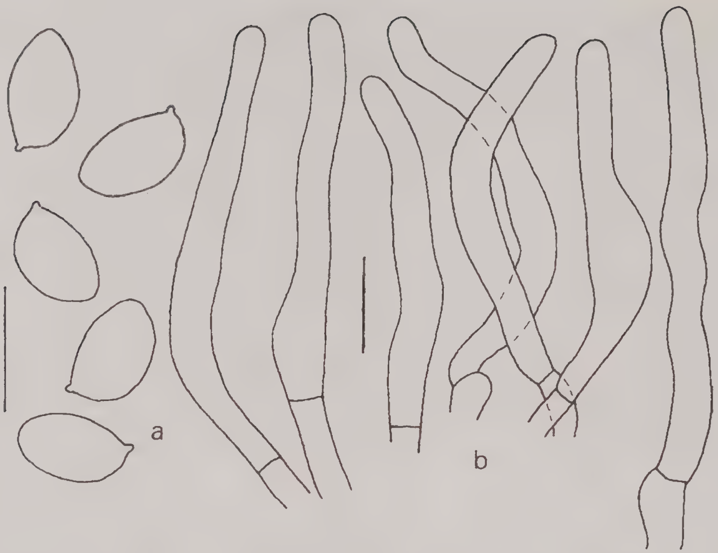

Fig. 4. *Crepidotus calolepis*. a: basidiospores; b: cheilocystidia (Singer 8239) (scale bar = 10 μm).

such variation does not distinguish single collections, we interpreted the differences in the degree of development of gelatinized layers as part of the morphologic variation expected to occur among members of a population. For the taxonomic treatment of the material studied, it was better to evaluate the presence or absence of gelatinized layers than the degree of gelatinization, an opinion also shared by Nordstein (1990) and Senn-Irlet (1995).

The presence of both the fibrils and the gelatinized layers mentioned above are found not only in collections of *Crepidotus calolepis* according to reports in the literature (Cooke1884-1886; Jahn 1966; Murrill 1917; Pegler 1977; Senn-Irlet 1995; Singer 1973; Watling and Gregory 1989), but also in the type specimens of *C. molliformis* from Mexico (Singer 1973) and *C. calolepioides* from Jamaica (Murrill 1913), two species segregated from *C. calolepis* according to Singer (1973). The microscopic data obtained from the type reexamination of these two samples are summarized and discussed below (fig. 10 a-b & e-g). The specimens supporting these species and those of *C. calolepis* var. *heterocystis* also described from Mexico, are interpreted here as belonging to a single taxon. In our opinion the taxonomic distinction of var. *heterocystis* can not be justified since the microscopic variation shown by the specimens is included in the range of the species variation as here interpreted. We have found the shape of cheilocystidia to be consistent among the collections examined. Along a single gill edge some cheilocystidia having the same shape pattern can be variably flexuous, straight, moderately curved or even with constrictions. Nordstein (1990) has observed a similar variation in European specimens treated as *C. calolepis*. The three collections considered by Singer as var. *heterocystis* (included above) exhibit differences with regard to these structures: whilst in collection *8256* flexuous elements are more or less common on the lamella edge (fig. 3c), in coll. *8029* (holotype) they are less frequent (fig. 3b), and in coll. *8239* they are practically absent (fig. 4b). The limitations inherent in the study of these herbarium samples prevent us from developing an objective evaluation of the frequency of the flexuous forms. As such cheilocystidia, as described by Singer (1973), are not unique to separate single collections, we could not justify using the degree of distortion of the shape of these structures as a reliable taxonomic distinguishing feature. For the time being, we interpret the materials of var. *heterocystis* as showing part of the cheilocystidia variation of *C. calolepis*.

Taxa from subsect. *Defibulatini s.* Singer (*Crepidotus levisporus* and allied taxa excluded) mentioned above make this group of species consistent. This in part supports several authors' concept of an isolated infrageneric taxon (Hesler and Smith 1965; Nordstein 1990; Pilát 1948; Senn-Irlet 1995; Singer 1947, 1973, 1986; Watling and Gregory 1989). The taxonomic interpretation of it could be resolved through the proposal of Subg. *Crepidotus* s. str. Senn-Irlet (1995). Furthermore, phylogenetic analysis based on molecular data (at least with specimens related to this group currently sequenced by some authors) suggests natural affinities among the taxa placed here (Aime and Miller 2002; Aime et al. 2002; Senn-Irlet and Hofstetter 1996). With regard to *C. calolepis* and *C. mollis,* the strikingly pigmented, incrusted hyphae present on the pileipellis of the specimens of the former, are not found in collections of *C. mollis*, as it is currently circumscribed (Senn-Irlet 1995; Singer 1973). The wider basidiospores in *C. calolepis*, in combination with the characteristics (macro- and microscopic) of the pileus surface are useful to separate it from *C. mollis*. We agree with Senn-Irlet (in litt.) that mating studies will provide additional information to support a robust species concept between both taxa.

3. *Crepidotus croceitinctus* Peck **Figure 5**

Crepidotus croceitinctus Peck, Ann. Rep. N.Y. Stat. Mus. 39: 72, 1886.
Synonym: *C. subcroceitinctus* Hesler & A.H.Sm., North American Species of *Crepidotus*: 139, 1965.

Most relevant data obtained in collection studied are: **pileus** 13-23 mm wide, cream-yellow to yellow (4A4-5), with scattered, whitish fibrillose tomentum, then some areas of the disc paler, semicircular to more or less rounded flabelliform, convex, margin slightly striate, with a moderate abundance of whitish mycelium at the base. **Lamellae** concolorous to somewhat darker, edges fimbriate. **Basidiospores** 6.4-8 x (4.8-) 5.6-7.2 μm, $RM = 7$ x 6.2 μm, $Q = 1.15$, broadly ellipsoid, at times somewhat subglobose, verrucose to coarsely verrucose, yellowish-brown, thick-walled (up to 0.5 μm thick). **Cheilocystidia** 20-40 x 3-6 μm, with apex (3-) 5-8 (-9) μm wide, narrowly clavate to clavate, commonly contorted, flexuous, with short outgrowths or with a knobbed apex, hyaline, clampled, thin-walled. **Pileipellis** a cutis composed of more or less compactly arranged hyphae, with scattered, prostrate to erect terminal hyphae, which are more abundant in certain areas, then almost in a gradual transition between a cutis and a trichoderm, towards the rear portion the layer is somewhat loosely disposed with a variable presence of terminal

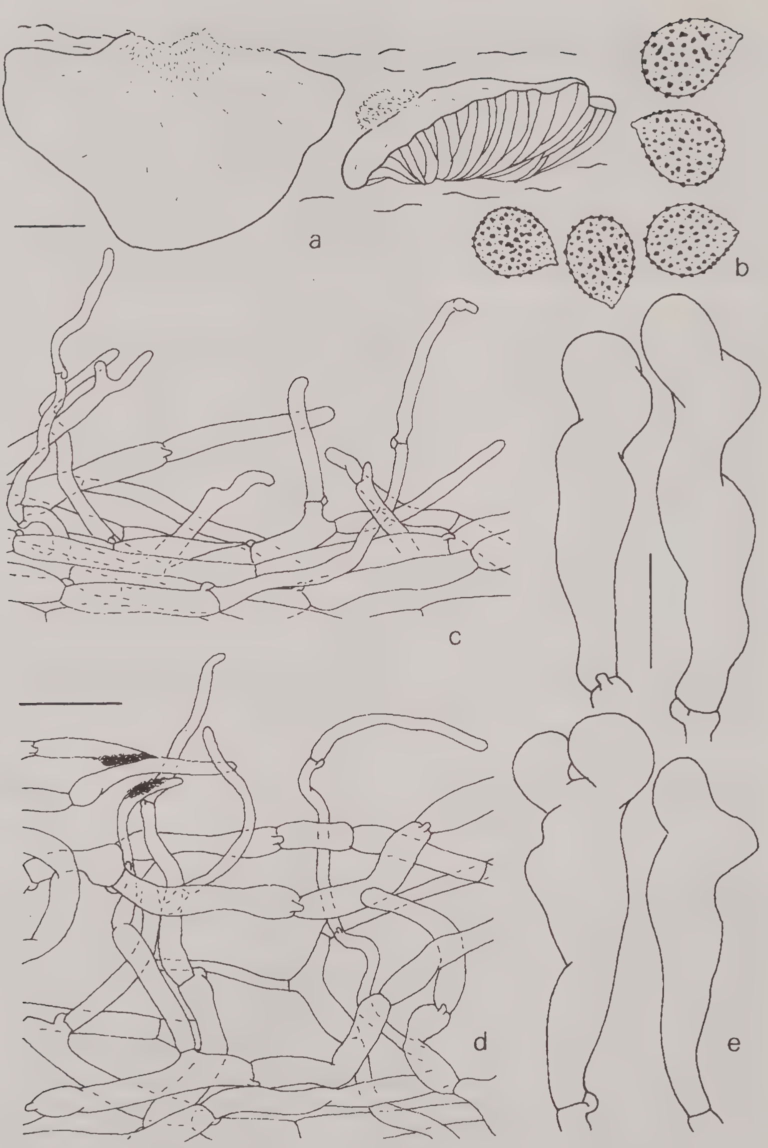

Fig. 5. *Crepidotus croceitinctus*. a: basidiomes; b: basidiospores; c: pileipellis (near middle portion of pileus); d: pileipellis (towards the rear portion of pileus); e: cheilocystidia (Bandala 3706) (scale bar = 10 μm, except a = 5 mm; c-d = 25 μm).

hyphae, all hyphae are yellowish to pale yellowish-orange, some segments more pigmented or even obscurely incrusted, a certain kind of incrusted, yellowish-brown material is evident in some parts. **Clamp Connections** in all tissues. For more macro- and microscopic details see Bandala and Montoya (2000b).

Habitat. Subgregarious, on rotten trunk, in a mesophytic forest.

> **SPECIMENS EXAMINED**. **MEXICO**. **PUEBLA**: **Chiconcuautla Co**., San Cristóbal Xochipehuala, 3-IX-2002, *Bandala 3706* (XAL).

Remarks. This new finding of the species from N Puebla records its most northern occurrence at present known in Mexico. As described from New York (USA), *C. croceitinctus* nowadays shows a fragmented distribution along the American Continent (Peck 1886; Hesler and Smith 1965; Singer 1953,1973; Pereira 1990; Senn-Irlet and De Meijer 1998; Bandala and Montoya 2000b).

4. ***Crepidotus latifolius*** group

Among the species of *Crepidotus* having baculate basidiospores, *C. latifolius* and *C. praelatifolius* are macroscopically distinctive because both produce small (often densely gregarious) basidiomes in combination with a hymenophore with very broad lamellae. These latter are somewhat spaced and consistently broad. The width of the lamellae is out of proportion in relation to the context width and also to the pileus length, hence commonly extending beyond pileus margin and producing a rather exposed hymenophore. The basidiomes appearance is then somewhat asymmetrical (figs. 6a, d & g; 7a). The examined specimens representing this group share the variation of most characters of taxonomic importance (basidiome color, both basidiospore size and ornamentation, pileipellis structure). The morphologic distinction that we found between *C. latifolius* and *C. praelatifolius* is based on the cheilocystidia shape. Considering that the distinction between both is only based on a single character, we follow the arguments of Kuyper (1988) and Noordeloos (1987) with regard to an infraspecific interpretation, and recognize two varieties: the var. *latifolius*, characterized by apically rounded or more or less capitate cheilocystidia, and the var. *praelatifolius*, distinguished by the narrowly-lageniform (tapering upwards) cheilocystidia. For a discussion on *C. latifolius* var. *veraecrucis* see below (fig. 10c-d). Its type specimen was found to be an intermediate form of *C. palmarum*, therefore, the var. *veraecrucis* is considered a later synonym.

4a. ***Crepidotus latifolius*** Peck var. ***latifolius*** **Figures 6-7, Plate 1d-g**

Basionym: *Crepidotus latifolius* Peck, Bull. Torr. Bot. Club 26: 66, 1899.

Pileus 2-10 (-13) mm wide, semicircular or more or less flabelliform, some at first moderately ungulate, convex to plano-convex, finally applanate, laterally or almost dorsally attached, often with a knob-like point of attachment and then somewhat campanulate, hygrophanous, whitish or somewhat white-grayish, at times pale white-yellowish, pale brownish with age, glabrous to weakly tomentose-fibrillose, commonly minutely fibrillose to rather villose towards the rear portion by the abundance of basal mycelium, margin straight, smooth or slightly striate, often with age exhibits certain process of deterioration being somewhat irregular and then reducing the pileus surface and exposing part of the lamellae. **Lamellae** adnate to narrowly adnate, broad to very broad, 2-5 (-6) mm wide, ventricose, often projecting beyond the margin of the pileus, whitish to whitish-yellow, gradually pale pinkish-brown to brownish, brown or somewhat reddish-brown in advanced stages of development, edges whitish, fimbriate to moderately fimbriate, subdistant to distant, converging to a lateral point, with lamellulae of different length. **Stipe** absent. **Context** whitish, very thin (< 0.5 mm wide), then the pileus is somewhat submembranous. **Odor** none. **Taste** not distinctive.

Basidiospores 5.5-7.5 (-8) x (4.5-) 5-6.5 (-7) μm, *RM* = 5.9-6.4 x 5.2-6.1 μm, *Q* = 1.06-1.14, subglobose, slightly attenuated towards the hilar appendix, then with a weak suprahilar depression, at times somewhat broadly subellipsoid, spinose to finely verrucose seen under light microscope, baculate when observed under SEM, with more or less homogeneous, short, conical-truncate protuberances; thick-walled (up to 0.5 ?m wide), yellowish to pale yellowish-brown, ornamentation darker, brownish-orange in mass. **Basidia** 25-35 x 7-8 (-9) μm, tetrasporic, clavate to clavate-ventricose, hyaline, clamped. **Pleurocystidia** none. **Cheilocystidia** (20-) 22-60 x (3-) 4-9 (-10) μm, more or less narrowly utriform, with a subcapitate or capitate apex 7-12 (-14) μm wide, often clavate-capitate or subcylindric-capitate, abundant, projecting beyond the hymenium level, forming a moderately dense layer along lamella edge, hyaline, thin-walled, clamped. **Pileipellis** a cutis of more or less interwoven, thin-walled, cylindric, colorless hyphae 4-9 μm wide, terminal hyphae scattered, prostrate to semierect, rarely erect, they are more frequent towards the rear portion where the hyphae are moderately more loosely arranged, then forming an irregular transition between a cutis and a trichoderm, in this zone the terminal hyphae are somewhat more erect and intricate depending apparently on the abundance of superficial tomentum, terminal elements cylindric to clavate or sublageniform, some tapering towards the tip, straight to moderately flexuous, hyaline, at times with minute yellowish incrustations (but not forming a pigmented layer), thin-walled, ungelatinized. **Pileus trama** with hyaline, more or less compactly interwoven, cylindric to ventricose, thin-walled hyphae up to 12 (-14) μm wide, in mounted sections sometimes the loosely arranged upper portion of the pileus contrasting with the more compact disposition of the pileus trama hyphae. **Hymenophoral trama** subregular to irregular, hyphae similar to the context; subhymenium poorly differentiated, with short-subglobose hyphae. **Clamp Connections** present in all tissues.

Habitat. Densely gregarious to gregarious, rarely scattered, sometimes with a more or less imbricate aspect, on decaying trunks or stumps, in mesophytic forest.

> **SPECIMENS EXAMINED**. MEXICO.— OAXACA: Sierra Mazateca, near Huautla de Jimenez, Rancho del Cura, 7-VII-1969, *Singer M8284* (F).— VERACRUZ: Parque Ecológico Fco. J. Clavijero, 22-V-1990, *Montoya 1746*; 26-VI-1992, *Bandala 2081*; 12-V-2001, *Bandala 3300, 3304* (all at XAL).
>
> **ADDITIONAL SPECIMENS EXAMINED**. USA. — OHIO: Cuyahuga Co.,Cleveland, 4-VI-1944, leg. Walters 5, *Smith 66263* (MICH, as *C. latifolius*).— TENNESSEE: Knoxville, Baring Woods, 6-VII-1939, *Hesler s.n.* (TENN 12270, as *C. latifolius*).

Remarks. The distinctive small basidiomes with very broad lamellae is what macroscopically characterizes *C. latifolius* and its varieties. The basidiospores and cheilocystidia can also be useful to separate them from *C. applanatus* (Pers.) Kumm.

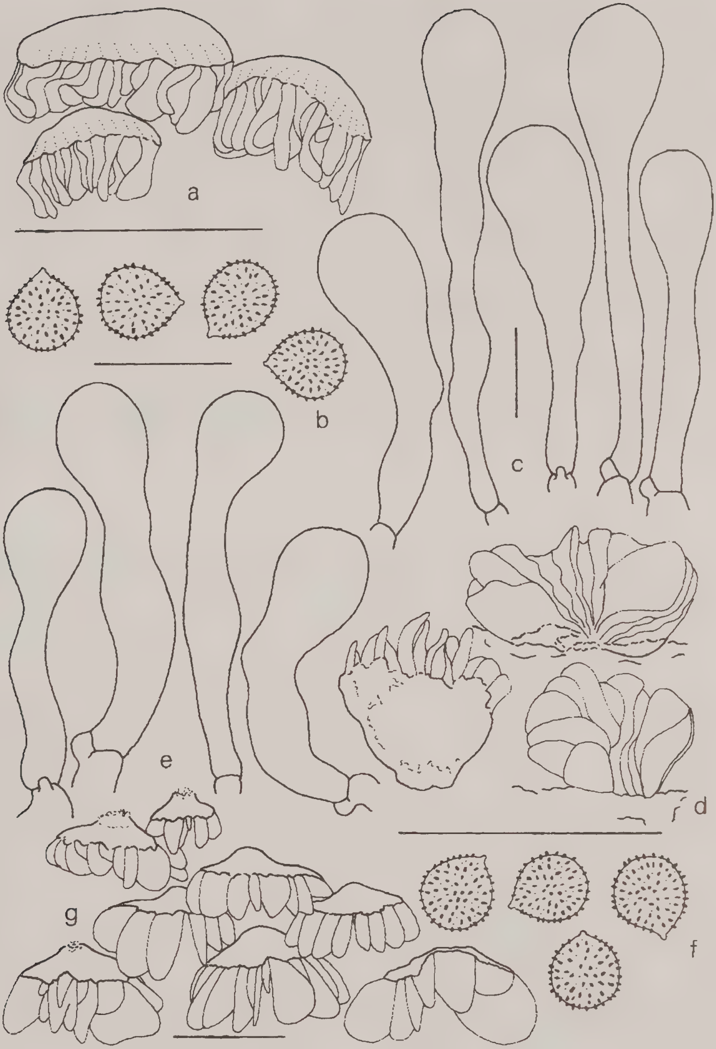

Fig. 6. *Crepidotus latifolius* var. *latifolius*. a: basidiomes; b: basidiospores; c: cheilocystidia (Smith 66263); d: basidiomes; e: cheilocystidia; f: basidiospores (Singer 8284); g: basidiomes (Bandala 3304) (scale bar = 10 μm, except a = 3 mm; e & g = 5 mm).

and relatives. Such microscopic characters show constant differences between the collections examined but require careful observation. In the samples of the group *C. latifolius* examined most basidiospores show a different form, characterized by being rounded but attenuated towards the hilar appendix, thus appearing less globose than those of *C. applanatus*. The basidiospores in the collections of both varieties (*latifolius* and *praelatifolius*) seen as a population are somewhat smaller (slender) in comparison with those of *C. applanatus*, but based solely on this character (basidiospore size), one single collection of that group could hardly be separated from the small-spored specimens of *C. applanatus*. In members of this latter species the basidiospores are spherical, but in terms of mean values of *Q* (length/width ratio) the differences are minimal: 1.00-1.12 (Senn-Irlet 1995) or 1.00-1.10 (Nordstein 1990; Bandala 2000) in *C. applanatus* versus 1.06-1.14 in the 'group' *C. latifolius*. In the collections belonging to *C. applanatus* var. *applanatus s. str.* Senn-Irlet (1995), the cheilocystidia are more rarely utriform, but consistently clavate to narrowly-clavate or somewhat cylindric. The lamellae edges of specimens of *Crepidotus latifolius* var. *latifolius*, however, could also bear clavate forms mixed with utriform cheilocystidia. See below *Crepidotus latifolius* var. *praelatifolius* for differences compared with *C. applanatus* var. *subglobiger* Singer *s. str.* Senn-Irlet (1995).

About 24 American taxa of *Crepidotus*, including *C. latifolius* (and its vars.) constitute the core of species related to *C. applanatus* within sect. *Sphaerula* Hesler & A.H. Sm. (or subsecc. *Porpophorini* Singer) (Hesler and Smith 1965; Singer 1973, 1986). In most cases minor macroscopic differences, which indeed show a certain overlapping, have been considered as supporting their taxonomic segregation. With regard to the hymenophore, however, there is a distinctive morphologic pattern which makes the group of specimens representing *C. latifolius* different macroscopically (figs. 6a, d & g; 7a). According to descriptions in the literature (Singer 1947, 1973; Hesler and Smith 1965) specimens of the core of species of sect. *Sphaerula* exhibit a rather continuous variation in the dimensions of the basidiome (including the relation pileus-lamellae together), which often complicates the taxonomic treatment of the samples based solely on their macroscopic appearance. Comparing such information with that recorded during our study of fresh materials, and that obtained after an examination of several type or authentic collections of members of this group related to Mexican taxa (Bandala 2000), the data revealed that in the species that embrace relatively small specimens (e.g. *Crepidotus applanatus*, *C. avellaneus* Hesler & A.H. Sm., *C. conchatus* Hesler & A.H. Sm., *C. cuneiformis* Pat., *C. subapplanatus* Hesler & A.H. Sm., *C. truncatus* Petch, among others), even the lamellae could be moderately broad. However, the hymenophore is comparatively proportional with regard to the pileus length and context width, the basidiomes being thus almost entirely proportional in overall appearance. Outside the core of species around *C. applanatus* a similar pattern of hymenophore could be found among the basidiomes of species producing small basidiomes, e.g. *C. cesatii* (Rab.) Sacc., *C. epibryus* (Fr.: Fr.) Quél., *C. palmarum* or *C. variabilis* (Pers.: Fr.) P. Kumm. The relation between lamellae and both pileus length and context width should be more accurately analyzed when comparing the samples macroscopically, because this could avoid misidentifications.

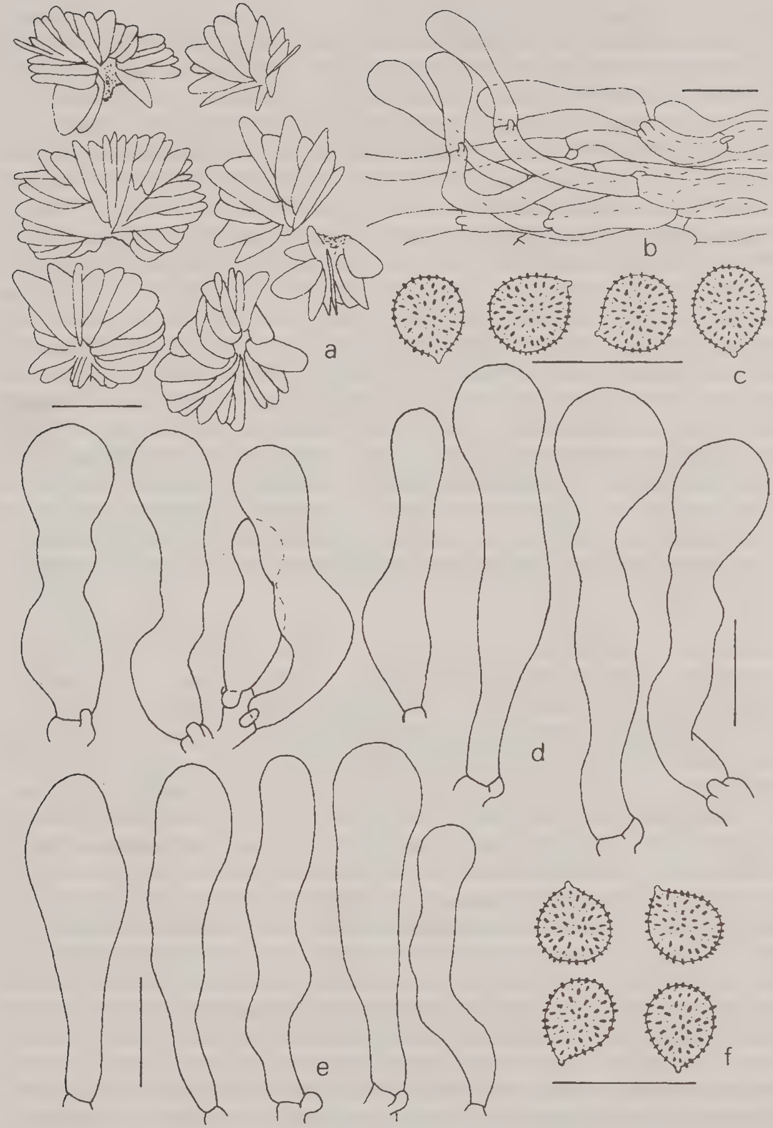

Fig. 7. *Crepidotus latifolius* var. *latifolius*. a: basidiomes (Bandala 3300); b: pileipellis; c: basidiospores; d: cheilocystidia (Montoya 1746); e: cheilocystidia; f: basidiospores (Lloyd 49964) (scale bar = 10 μm, except a = 5 mm; b = 15 μm).

In this regard we are not completely convinced by the proposal of lectotypification of *Crepidotus latifolius* (var. *latifolius*) with the collection *Lloyd 49964* (U.S.A. Ohio: near Cincinnati, dated 1902, BPI). In the diagnosis Peck (1899) described *C. latifolius* with '... pileus very thin, submembranous, ... 3-6 mm broad, ... white, lamellae very broad, suborbicular, 5-6 times as wide as the thickness of the flesh ... extending beyond the margin of the pileus...'. These features are in fact found in the different collections from the U.S.A. and Mexico included above. In the protologue Peck (1899) indicated '... Ohio, Lloyd...' referring to the type, however, we did not find it at Ch. Peck's Herbarium (NYS), it was not apparently conserved. This was already pointed out by Singer (1947) who suggested considering Peck's taxon invalid. Hesler and Smith (1965) found at BPI the cited collection *Lloyd 49964*, and selected it as the lectotype of *C. latifolius* (var. *latifolius)* a selection later accepted by Singer (1973) too. We have examined the mentioned material of Lloyd, which is composed of several elements but not in optimum conditions. This sample does not have notes of the macroscopic features when fresh, and its present state of preservation limits the complete macroscopic interpretation of the species as described by Peck. Although most basidiomes are broken, in overall appearance the elements resemble small forms of members of sect. *Sphaerula* around *Crepidotus applanatus*. Furthermore, the gill edge when available could hardly be revived, hence our microscopic evaluation of it was based on a very reduced number of cheilocystidia (fig. 7e-f). In a note accompanying the sample L.R. Hesler underlined a similar fact. Most relevant microscopic observations that we made on *Lloyd 49964* are the following:

Basidiospores 5.5-6.5 x (4.5-) 5-6 (-6.5) μm, *RM* = 5.9 x 5.4 μm, *Q* = 1.10, subglobose, commonly constricted towards apiculus, minutely warted to punctate, distinctly baculate under SEM (plate 1g), yellowish to pale yellowish. **Basidia** tetrasporic, clavate, hyaline, clamped. **Pleurocystidia** absent. **Cheilocystidia** 35-42 x 5-7 μm, with apex 7-10 (-13) μm, clavate to subcylindric, hyaline, rare, almost inconspicuous (due to the difficulties in reviving the edge of lamellae), clamped. **Pileipellis** a cutis of prostrate, interwoven hyphae 3-7 μm wide, hyaline to pale yellowish (not pigmented), with some erect or moderately erect, undifferentiated terminal elements, then such areas more or less in transition between a cutis and a trichoderm, pellis poorly differentiated from the context hyphae, which are more compactly arranged, hyaline to pale yellowish, 5-15 μm wide, thin walled, clamped. **Hymenophoral trama** regular to irregular, hyphae 5-10 μm wide, hyaline, clamped. These data are similar to those included by Hesler in his note: '...basidiospores 4.5-6 x 4.5-6 μm, globose to subovoid, punctate, brown; cheilocystidia 32-43 x 7-8 μm, clavate-subcapitate, few; cuticle a cutis, with more or less erect, slender, colorless hyphae which are scattered or numerous at times approaching a trichodermium; clamp connections present on the epicuticular hyphae...'. This latter information, however, differs from that described by Hesler and Smith (1965 p. 54), which suggests that they provided a composite description based on Lloyd's material as well as on the macro- and micromorphologic information from the additional collections (above included) that they interpreted as *Crepidotus latifolius.* Although Singer (1973) compared *Lloyd 49964* with his samples, data in his description clearly indicate that it was based solely on the two collections that he considered from Mexico and Bolivia.

The collections examined from the U.S.A. and that of Singer from Mexico (Oaxaca) share with our collections from Veracruz the same morphologic pattern (figs. 6-7). The former correspond to the materials studied by Hesler and Smith (1965) and Singer (1973), respectively, all treated as *Crepidotus latifolius* (var. *latifolius)*. These specimens are well preserved and differ from *Lloyd 49964* by their distinctive small-sized, more or less densely gregarious basidiomes, with thin flesh and very broad lamellae, even in their dry condition (as depicted in fig. 6a & d). The microscopic description provided above is based on the collections mentioned, including the Mexican material. These present a similar variation in the basidiospore characteristics (size, shape, ornamentation) and exhibit similar cheilocystidia, though new Mexican collections were the ones that allowed us to carry out a more complete study of these latter structures (figs. 6-7). Since the group of species around *Crepidotus applanatus* may possess moderately small basidiomes, being macroscopically similar superficially, and microscopically exhibiting similar ranges of size and shape of both cheilocystidia and basidiospores, we should be cautious about considering the collection *Lloyd 49964* as a lectotype for *C. latifolius* (var. *latifolius*). This latter collection perhaps represents a small form of *C. applanatus*. With the available information we do not have enough evidence to interpret the elements of this collection as members of *C. latifolius*. We agree with Hesler, Smith and Singer that the samples (included above) from Cleveland, Knoxville (USA) and Oaxaca (Mexico) that they studied support the concept of *C. latifolius* as circumscribed by Peck, which embraces the variation of our collections from Veracruz. However, to fulfill the nomenclatural rules, in our opinion, it would be desirable to review Peck's (or Lloyd´s) herbarium in order to look for the existence of another specimen (still unidentified) or even a topotypical specimen before adopting that lectotype.

4b. *Crepidotus latifolius* var. *praelatifolius* Figure 8a-e. Plate 1h

Crepidotus latifolius var. *praelatifolius* (Murrill) Singer, Beih. Nova Hedwigia 44: 359, 1973.
Basionym: *C. praelatifolius* Murrill, Bull. Torr. Bot. Club 67: 230, 1940.

Pileus 1-3 mm wide, more or less semicircular, at times somewhat flabelliform, some at first moderately ungulate, convex to plane, laterally or almost dorsally attached, hygrophanous, whitish or somewhat white-grayish, some white-yellowish, pale brownish with age, tomentose-fibrillose to glabrescent, more fibrillose towards the rear portion by the abundance of basal mycelium; margin smooth or slightly striate; surface often showing certain process of deterioration, being somewhat irregular and then reducing the pileus area, exposing part of the lamellae. In the holotype the lamellae are practically held by a very small fragment of pileus. **Lamellae** adnate to narrowly adnate, broad to very broad 2-5 (-6) mm wide, ventricose, often projecting beyond the margin of the pileus, whitish, whitish-yellow to brown-yellowish or brownish, edges whitish, moderately fimbriate, subdistant to distant, converging to a lateral point, with lamellulae of different length. **Stipe** absent. **Context** whitish, very thin (< 0.5 mm wide), then the pileus is somewhat submembranous. **Odor** none. **Taste** not distinctive.

Basidiospores 5.5-6.5 x 5-6 (-6.5) μm, *RM* = 6.1-6.2 x 5.5-5.8 μm, *Q* = 1.07-1.14, subglobose, slightly attenuated towards the hilar appendix, then with a weak suprahilar depression, at times somewhat broadly subellipsoid, spinose to finely verrucose seen under light microscope, baculate when observed under SEM, with more or less homogeneous, short, conical-truncate protuberances; thick-walled (up to 0.5 μm wide), yellowish to pale yellowish-brown, ornamentation darker, brownish-orange in mass. **Basidia** 15-25 x 6-8 μm, tetrasporic, clavate to cylindric-clavate, hyaline, clamped. **Pleurocystidia** none. **Cheilocystidia** 23-65 (-70) x (3.5-) 5-9 (-10) μm, narrowly lageniform, tapering upwards (not acute), apex 2.5-6 (-7) μm wide, at times subcylindric or somewhat narrowly subutriform and with a moderately rounded tip, straight or slightly flexuous, projecting beyond the hymenium level, more or less abundant but somewhat scattered along the lamella edge, hyaline, thin-walled, clamped. **Pileipellis** a cutis of more or less interwoven, thin-walled, cylindric, colorless hyphae 3-7 (-9) μm wide, terminal hyphae scattered, prostrate to semierect, towards the rear portion the hyphae are more loosely arranged then forming an irregular transition between a cutis and a trichoderm, in this zone the hyphae are somewhat more erect and intricate depending apparently on the abundance of superficial tomentum, terminal elements cylindric to clavate, hyaline, thin-walled, ungelatinized. **Pileus trama** thin, with hyaline, more or less compactly interwoven, cylindric to ventricose, thin-walled hyphae 3-15 μm wide, in mounted sections sometimes the loosely arranged upper portion of the pileus contrasts with the more compact disposition of the context hyphae. **Hymenophoral trama** subregular to subirregular, hyphae 4-10 μm wide, similar to context; subhymenium poorly differentiated, with short-subglobose hyphae. **Clamp Connections** present in all tissues.

Habitat. Gregarious, sometimes with a more or less imbricate aspect, on a decaying trunk, in mesophytic forest.

> **SPECIMENS EXAMINED. MEXICO**.— **VERACRUZ**: km 2.5 old road Xalapa-Coatepec, near Instituto de Ecología, 24-V-1995, *Bandala 2736* (XAL).
>
> **ADDITIONAL SPECIMENS EXAMINED. U.S.A.**— **FLORIDA**: Gainsville, 8-IX-1938, *Rhoads s.n.* (Holotype, FLAS; Isotype MICH). ***Crepidotus applanatus* var. *subglobiger*.** **SPAIN**. — **MADRID**: Rascafría, 19.XI.1975, *Rollán s.n.* (AH 473).— **SEGOVIA**: Boca del Amo, 13.XI.1978, leg. *Soc. Mic. Castellana* (AH 5171).

Remarks. Minor differences in the size of both pileus and lamellae have been the basis for the taxonomic separation between *C. praelatifolius* and *C. latifolius* (Hesler and Smith 1965; Murrill 1940; Pilát 1950; Singer 1947, 1949). We found among the samples of this group examined that the macroscopic variation overlaps, as does that exhibited by the basidiospores (size, shape, ornamentation). Except for the narrowly-lageniform cheilocystidia (fig. 8b & e), our examination of the samples did not reveal any other morphocharacter that could offer reliable taxonomic differences to segregate Murrill's taxon. We share Singer's (1973) opinion and consider that on the basis of this single distinctive character *C. praelatifolius* should be recognized as a variety of *C. latifolius*. The reduction of the pileus surface, that leaves a great part of the lamellae exposed as shown by the holotype, is occasionally found among the elements of var. *latifolius*. This characteristic is apparently indicative of differences between collections of both varieties. However, before considering it to be of taxonomic value, an evaluation during the developement of the basidiomes is still required.

Comparatively speaking, microscopically the var. *latifolius* is superficially similar to *C. applanatus* var. *applanatus* (see above), as *C. latifolius* var. *praelatifolius* is with regard to *C. applanatus* var. *subglobiger s. str.* Senn-Irlet (1995). In this latter case, the combi-

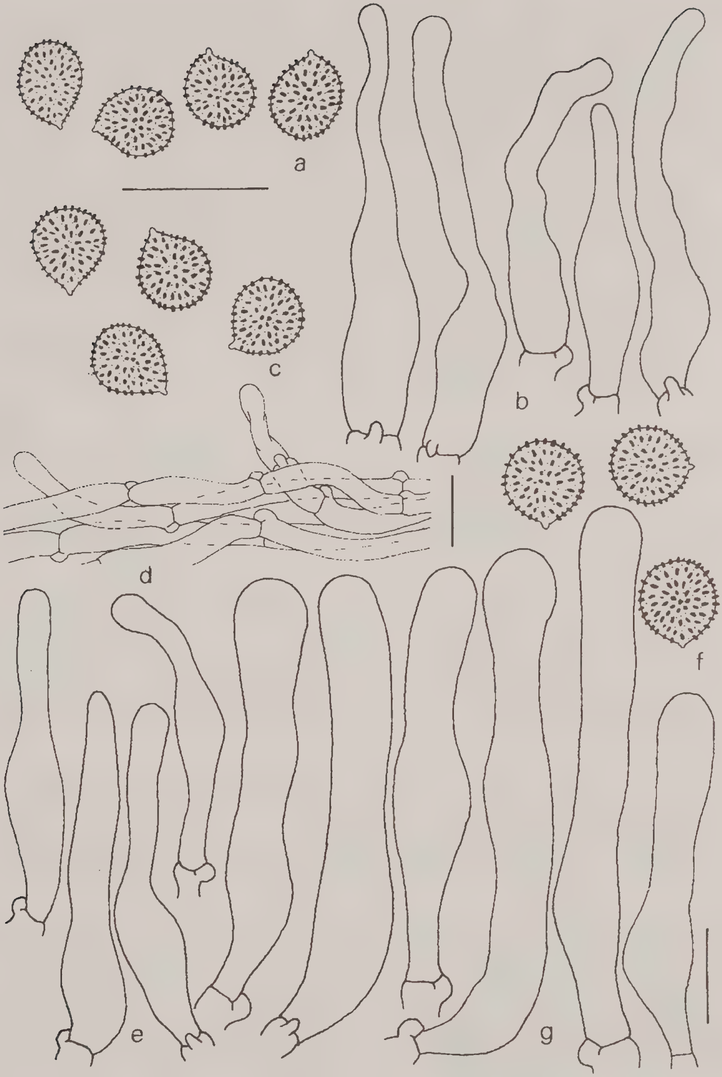

Fig. 8. a-e: *Crepidotus latifolius* var. *praelatifolius*, a: basidiospores; b: cheilocystidia (Rhoads s.n.); c: basidiospores; d: pileipellis; e: cheilocystidia (Bandala 2736). f-g: *Crepidotus applanatus* var. *subglobiger*, f: basidiospores; g: cheilocystidia (AH 5171) (scale bar = 10 μm, except d = 15 μm).

nation of gregarious, small, very broad-lamellate basidiomes also distinguish the var. *praelatifolius* from var. *subglobiger*. At microscopic level, apart from the basidiospore characteristics discussed above (see *C. latifolius* var. *latifolius*), specimens of both varieties can be distinguished by the cheilocystidia. These varieties show a similar pattern of cheilocystidia shape (lageniform), but when compared these structures are clearly different in size and overall appearance. Descriptive data provided by Seen-Irlet (1995) about the cheilocystidia of *C. applanatus* var. *subglobiger* ['... (20-) 30-75 (-90) x 5-10 μm, cylindrical, narrowly lageniform or narrowly utriform, mixed with some flexuous, angled or forked ones, rarely some subcapitate...'] are useful when comparing it with var. *applanatus*, and suggest differences with var. *praelatifolius*. Our examination of two of the collections of *C. applanatus* var. *subglobiger* treated by that author (*AH 473*; *AH 5171*), revealed cheilocystidia (28-) 32-75 (-80) x 6-11 (-12) μm, with apex (4-) 5-9 (-10) μm wide (fig. 8f-g). This indicates therefore, that the var. *praelatifolius* can be recognized by its smaller and slender cheilocystidia, showing a more narrowly lageniform pattern than those of var. *subglobiger*.

5. *Crepidotus palmarum* Singer **Figures 9-10c-d. Plate 1i-l**

Crepidotus palmarum Singer, in Singer & Digilio, Lilloa 25: 406, 1951.

Synonym: *C. luridus* Singer var. *luridus*, *Beih. Nova Hedwigia* 44: 479, 1973; *C. luridus* var. *minor* Singer, *Beih. Nova Hedwigia* 44: 479, 1973; *C. luridus* var. *oaxacae* Singer, *Beih. Nova Hedwigia* 44: 479, 1973; *C. latifolius* var. *veraecrucis* Singer, *Beih. Nova Hedwigia* 44: 360, 1973.

For descriptive details see Bandala and Montoya (2000b). Specimens studied have **basidiospores** (4.8-) 5.6-8 x 4.8-6.5 (-7) μm, *RM* = 5.8-6.9 x 5.1-5.8 μm, *Q* = 1.13-1.19, broadly ellipsoid, verrucose with moderately coarse verrucae. **Cheilocystidia** 20-50 x 4-8 μm, clavate to narrowly clavate or somewhat narrowly utriform, with a rounded, capitate or subcapitate apex (6-) 7-13 (-14) μm, abundant, hyaline, clamped. **Clamp Connections** present in all tissues.

Habitat. Subgregarious, on rotten branches, in mesophytic and tropical forests.

> **SPECIMENS EXAMINED**. **MEXICO**. **PUEBLA**: **Chiconcuautla Co**., San Cristóbal Xochipehuala, 3-IX-2002, *Bandala 3707-A* (XAL). **VERACRUZ**: 7 km S of Montepio, Estación Biológica de Los Tuxtlas, 20-VI-1969, *Singer M 8038* (F, as *C. cuneiformis*).

Remarks. The combination of moderately small, white basidiomes, broadly ellipsoid, verrucose basidiospores, clavate-capitate cheilocystidia, and clamped hyphae distinguish this species (Bandala and Montoya 2000b). This same combination of features was found in the specimen *Singer M 8038* (fig. 9d-f), consequently we considered it as representing a member of *C. palmarum*. Singer (1973) placed this collection under *C. cuneiformis* Pat. This latter species is recognized, however, because its basidiomes produce globose or spherical, punctate to spinose basidiospores (baculate seen under SEM) as observed in the type specimen (Guadaloupe: *Duss 31*, Herb. Patouilliard 405, FH) and as noted also by Hesler and Smith (1965) and Pegler (1983). Furthermore, the collection *Singer M 8761* holotype of *C. latifolius* var. *veraecrucis* (discussed below) can be assigned to *C. palmarum*. The noticeable verrucose, subglobose to broadly ellipsoid basidiospores exhibited by this latter specimen clearly excluded it taxonomically from the group of *C. latifolius* previously mentioned.

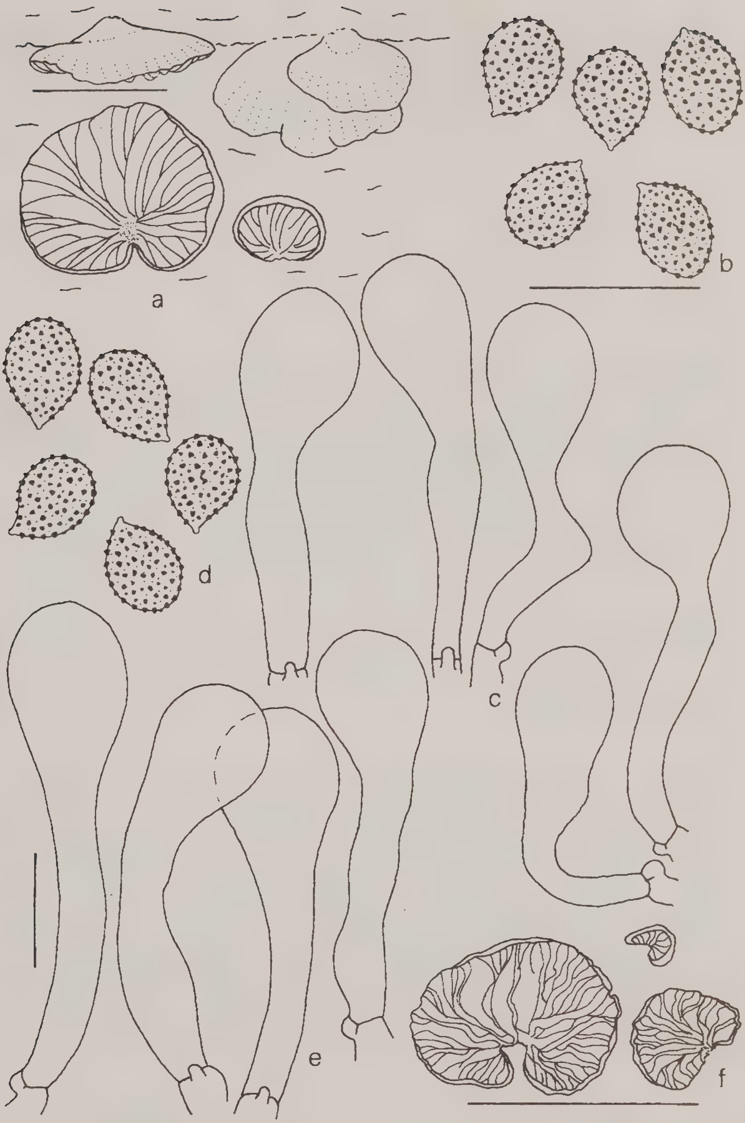

Fig. 9. *Crepidotus palmarum.* a: basidiomes; b: basidiospores; c: cheilocystidia (Bandala 3707-A); d: basidiospores; e: cheilocystidia; f: basidiomes (Singer 8038) (scale bar = 10 μm, except a & f = 5 mm).

In addition to previous records of *C. palmarum* from Morelos, Oaxaca and Veracruz (Singer 1973; Bandala and Montoya 2000b), the present report of the species from N Puebla as well as that of Krisai-Greilhuber *et al.* (2002) from Nayarit, show that *C. palmarum* is distributed throughout the country from coast to coast, almost following the line of the neovolcanic axis and towards the south of Mexico.

B. TYPE STUDIES

6. Crepidotus calolepioides **Figure 10a-b. Plate 1c**

Crepidotus calolepioides Murrill, Mycologia 5: 30, 1913.

HOLOTYPE: JAMAICA.Cinchona, Dec. 25- Jan. 8, 1908-1909, on a small dead branch of a deciduous shrub, *Murrill 556* (NY).

Basidiospores 7.5-10 x 5.5-7 μm, *RM* = 8.9 x 6.3 μm, *Q* = 1.43, ellipsoid, somewhat amygdaliform in side view, some weakly tapering towards the apex, smooth, thick-walled (up to 0.5 μm thick), dark to light brown-yellowish. **Basidia** tetrasporic, clavate, hyaline, clampless. **Pleurocystidia** none. **Cheilocystidia** not observed. **Pileipellis** a cutis of radially oriented, septate hyphae 5-15 μm wide, these are brown-orange to brownish colored, with a coarse or fine, inter or intraparietal incrusting brown pigment, forming an interrupted layer, variable in width, and which constitutes the scales on pileus surface, the terminal hyphae undifferentiated, often in groups, somewhat erect and then with a trichodermoid appearance. **Pileus trama** with a refringent, distinctive gelatinized layer underneath pileipellis, composed by more or less filamentous to cylindric, somewhat loosely and radially arranged, thin-walled, colorless hyphae 2-5 (-7) μm wide, downwards the hyphae are moderately compact, hyaline and tend to form a puzzle-like structure. **Hymenophoral trama** with poorly differentiated, gelatinized laterostrata. **Clamp connections** absent.

Remarks. The type consists of a fragmented basidiome and it is not possible to make a complete microscopic analysis of the gill edge. Although in a water color painting accompanying the material the pigmented fibrils or scales on pileus surface were not depicted, the notes on the fresh material describe the cap with '... minute fulvous conical setae ...'. Murrill (1913) described *C. calolepioides* with pileus surface decorated with minute, fulvous, conic elevations and emphasized that it resembles '... *C. calolepis*, but with minute conic elevations instead of tomentose-scaly ...'. Some authors listed *C. calolepioides* as a synonym of *C. calolepis* (Hesler and Smith 1965; Nordstein 1990; Senn-Irlet 1995), and the distinctive macro and microscopic morphocharacters of its type specimen suggest indeed that it shows the morphologic variation found in that species (see above). Therefore, we support the synonymy between *C. calolepiodes* and *C. calolepis*.

7. Crepidotus latifolius var. *veraecrucis* **Figure 10c-d. Plate 1k-l**

Crepidotus latifolius var. *veraecrucis* Singer, Beih. Nova Hedwigia 44: 360, 1973.

HOLOTYPE: MEXICO.VERACRUZ: 3 km S of Montepio, 30-VII-1969, *Singer M 8761* (F).

Basidiospores 6-7.5 (-8) x 4.5-6.5 μm, *RM* = 6.8 x 5.6 μm, *Q* = 1.21, broadly ellipsoid to subglobose, with a weak suprahilar depression, somewhat drop-shaped in frontal

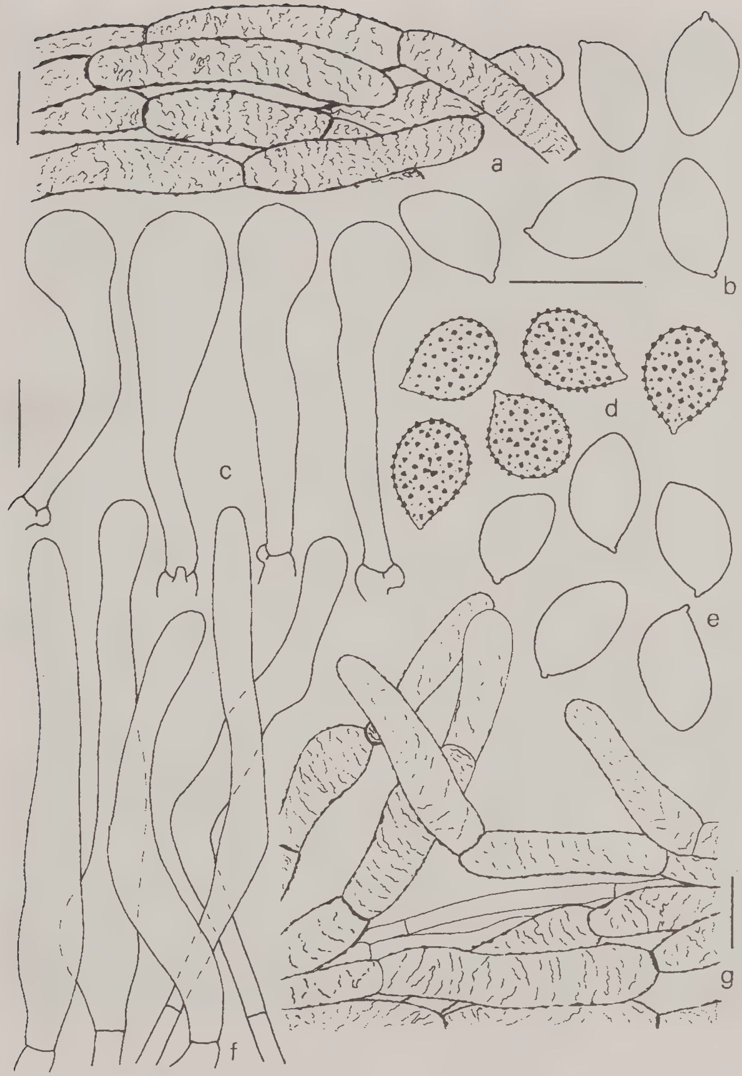

Fig. 10. a-b: *Crepidotus calolepioides*, a: pileipellis; b: basidiospores (Murrill 556); c-d: *Crepidotus latifolius* var. *veraecrucis*, c: cheilocystidia; d: basidiospores (Singer 8761); e-g: *Crepidotus molliformis*, e: basidiospores; f: cheilocystidia; g: pileipellis (Singer 8262) (scale bar = 10 μm, except a & g = 15 μm).

view, verrucose to finely verrucose, sometimes interconnected forming coarse, short lines, pale yellowish to yellowish with brownish orange ornamentation, moderately thick-walled (up to 0.5 μm wide); the verrucae seen under SEM are rounded or more or less conical, the wall bearing also small verruculae. **Basidia** 18-25 x 7-12 μm, tetrasporic, some bisporic, clavate, hyaline, clamped. **Cheilocystidia**: the gill edge hardly can be revived with KOH, it is difficult to recover it, hence our observations were made on a limited number of these structures: 20-40 x (3-) 4-6 (-8) μm, clavate or narrowly-clavate, with a more or less capitate or rounded apex 8-12 mm wide, some subcylindical elements are also present, hyaline, thin-walled, clamped. **Pileipellis**: the present state of preservation of the sample limits the complete study of the pileipellis. **Clamp connections** present.

Remarks. This variety described by Singer (1973) from Mexico was said to be macroscopically similar to the typical variety, but separated by '... somewhat pigmented pileus, variable cheilocystidia and very variable spores...'. We found that the basidiospores exhibited by the holotype have a different morphologic pattern (broadly ellipsoid, verrucose) that clearly indicates that this material belongs to a different taxon. Macroscopically the collection resembles specimens of *C. palmarum.* Based on the macroscopic data provided by Singer (1973), in combination with the basidiospores and cheilocystidia observed in the holotype, we concluded that specimen *Singer M 8761* corresponds to an intermediate form of *C. palmarum* (see above).

8. Crepidotus molliformis **Figure 10e-g. Plate 1b**

Crepidotus molliformis Singer, Beih. Nova Hedwigia 44: 441, 1973.

> **HOLOTYPE. MEXICO. MORELOS**: NW Tepoztlán, 1-VII-1969, ad trunci corticem arboris dicotyledoneae probabiliter *Quercus*, Singer *M8262* (F).

Basidiospores 8-9.5 (-10) x 5.5-6.5 μm, RM = 8.7 x 5.9 μm, Q = 1.47, ellipsoid to somewhat amygdaliform in side view, smooth, thick-walled (up to 0.5 μm wide), brown-yellowish to ochraceous. **Basidia** (18-) 20-27 (-30) x 8-10 μm, tetrasporic, clavate, hyaline, clampless. **Pleurocystidia** none. **Cheilocystidia** 25-78 x 4-8 (-9) μm, lageniform to narrowly lageniform, with apex 4-7 μm wide, some moderately cylindric, hyaline, clampless, abundant, immersed in a gelatinized matter, then forming a more or less refringent layer on lamella edge, often arising below hymenium from more or less loosely arranged, filamentous, commonly bifurcate, hyaline hyphae 2-5 (-8) μm wide. **Pileipellis** a cutis of radially oriented, septate, yellowish-brown to pale brown hyphae 5-15 (-20) μm wide, not or slightly gelatinized, forming an interrupted layer, variable in width and which constitutes the scales of pileus surface, coarsely or finely incrusted, with inter or intraparietal incrusting brown pigment, sometimes the incrustations forming lines in a more or less transversal arrangement, terminal hyphae undifferentiated, often in groups, somewhat erect and then with a trichodermoid appearance. **Pileus trama** with the upper portion, below the pileipellis, as a wide refringent, gelatinized layer composed of more or less filamentous to cylindric, somewhat loosely and radially arranged, thin-walled, colorless hyphae 2-7 (-9) μm wide, downwards the tissue is more compactly arranged, with cylindric or short-bifurcate hyphae 4-15 (-20) μm wide, hyaline, tending to form a puzzle-like structure. **Hymenophoral trama** with poorly differentiated, gelatinized laterostrata, which are more differentiated towards the lamella edge; mediostratum with cylindric and puzzle-like hyphae. **Clamp connections** absent.

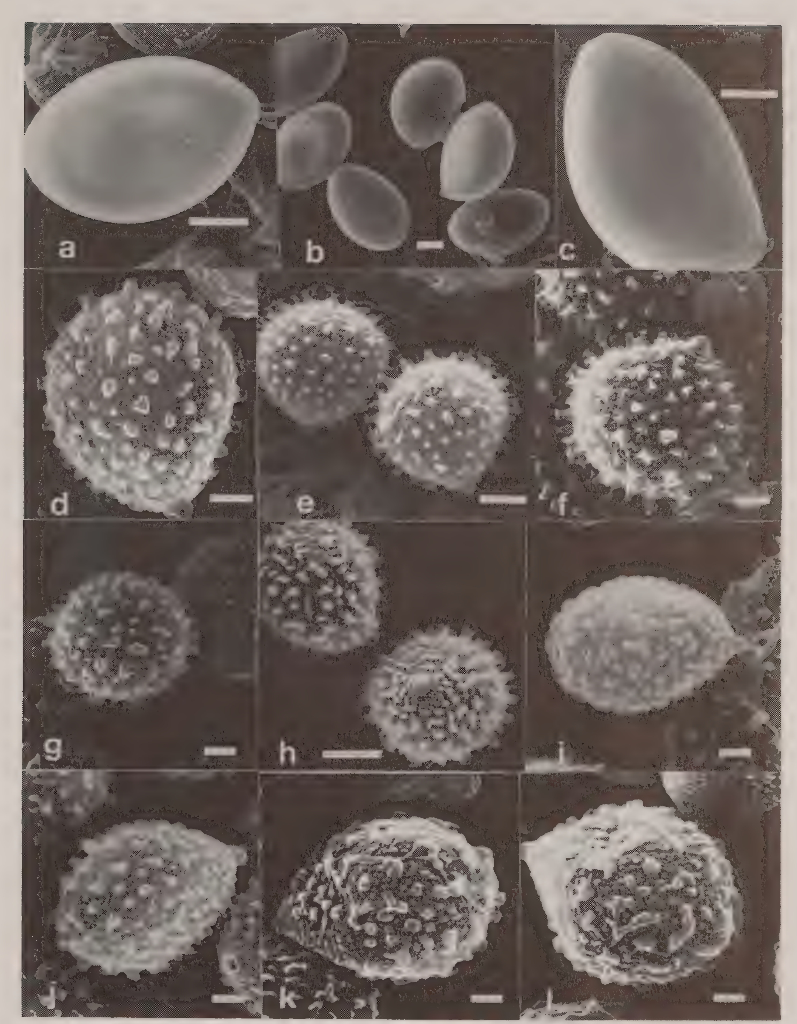

Plate 1. *Crepidotus* basidiospores (SEM): a-c: *Crepidotus calolepis* (a: Singer 8029, holotype of *C. calolepis* var. *heterocystis*; b: Singer 8262, holotype of *C. molliformis*; c: Murrill 556, holotype of *C. calolepioides*); d-g: *C. latifolius* var. *latifolius* (d: Smith 66263; e-f: Singer 8384; g: Lloyd 49964); h: *C. latifolius* var. *praelatifolius* (Rhoads s.n.); i-l: *C. palmarum* (i-j: Singer 8038; k-l: Singer 8761, holotype of *C. latifolius* var. *veraecrucis*) (scale bar = 1 μm, except a-c & e, h = 2 μm).

Remarks. In spite of the fact that the type specimen of *C. molliformis* clearly exhibits refringent, gelatinized layers in both pileus and hymenophoral trama, Singer (1973) excluded it from his '*stirps Mollis*' without making any comment on it. Although this author found *C. molliformis* to be '... macroscopically glabrous at maturity...' he emphasized its resemblance to *C. fulvotomentosus* Peck with regard to pileus surface. Peck´s taxon is accepted as a synonym of *C. calolepis* (Singer 1947, 1973; Hesler and Smith 1965; Nordstein 1990; Seen-Irlet 1995) and the degree of fibrillosity recorded for the specimen *Singer M 8262* is interpreted here as part of the individual variation. A taxonomic segregation between *C. molliformis* and *C. calolepis* would be weakly justified based on a transitional state of pileal characteristics. Microscopic features described above strongly relate Singer's specimen to the group of examined collections of *C. calolepis* (see above). Thus, macro- and microscopic characters are consistent enough to interpret the specimen *Singer 8262* as conspecific with this latter taxon.

The same collection, *Singer M 8262*, was used by Singer (1973 p. 445) under *C. sublevisporus* from Morelos, Mexico. This latter is treated as a synonym of *C. albidus* (Bandala and Montoya 2000a), and none of Singer's collections of this species from Morelos currently studied by us agree with the date provided by him (1-VII-1969). That mention was probably due to a printing error.

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Literature cited

Aime, MC, Baroni TJ, Miller OK. 2002. *Crepidotus thermophilus* comb. nov., a reassessment of *Melanomphalia thermophila*, a rarely collected tropical agaric. Mycologia 94: 1059-1065.

Aime, MC, Miller OK. 2002. Delayed germination of basidiospores in temperate species of *Crepidotus* (Fr.) Staude. Can. J. Bot. 80: 280-287.

Bandala, VM. 2000. Contribución al estudio del género *Crepidotus* (Fr.) Staude (Fungi, Agaricales) en México. Una revisión taxonómica de las especies conocidas. Ph.D. Tesis. Universidad de Alcalá, Alcalá de Henares, Spain. 234 p.

Bandala, VM, Montoya L. 2000a. A taxonomic revision of some American *Crepidotus*. Mycologia 92: 341-353.

Bandala, VM, Montoya L. 2000b. A revision of some *Crepidotus* species related to Mexican taxa. Mycol. Res. 104: 495-506.

Bandala, VM, Montoya L. 2002. *Crepidotus* (Agaricales) grupo *mollis* en el neotrópico: revisión taxonómica con énfasis en miembros relacionados con taxones mexicanos. p. 226. Abstracts IV Cong. Latinoamericano de Micología, Xalapa, Veracruz.

Bandala, VM, Montoya L., Moreno G. 1999. Two *Crepidotus* from Mexico with notes on selected type collections. Mycotaxon 72: 403-416.

Bigelow, HE. 1980. *Crepidotus nyssicola*. Mycologia 72: 1227-1231.

Cooke, MC. 1884-1886. Illustrations of British fungi. IV. William & Norgate, London.

Holmgren, PK, Holmgren NH, Barnett LC. (Eds.) 1990. Index Herbariorum. Part I. The herbaria of the world. 8va ed. New York Botanical Garden, New York.

Horak, E. 1964. Fungi Austroamericani, XI. Nova Hedwigia 8: 333-346.

Horak, E. 1977. *Crepidotus episphaeria* and related species from the Southern Hemisphere. Ber. Schweiz. Bot. Ges. 87: 227-235.

Horak, E., Desjardin DE. 2004. On two remarkable species of *Crepidotus* from Bonin Islands (Japan) and new records from Hawaiian Islands and Papua New Guinea. In: Cripps, C. (Ed.). Systematics, diversity, and ecology of fungi in forest ecosystems. NYBG (in press).

Hesler, LR. 1975. New species of *Crepidotus* (Fr.) Staude. Beih. Nova Hedwigia 51: 133-137.

Hesler, LR., Smith AH. 1965. North American species of *Crepidotus*. Hafner Publ., New York.

Jahn, H. 1966. Pilzgesellschaften an *Populus tremula*. Zeit. Pilzk. 32: 26-42.

Kornerup, A., Wanscher JH. 1978. Methuen handbook of colour. Methuen, London.

Krisai-Greilhuber, I., Senn-Irlet B., Voglmayr H. 2002. Notes on *Crepidotus* from Mexico and the south-eastern USA. Persoonia 17: 515-539.

Kühner, R., Romagnesi H. 1953. Flore analytique des champignons superieurs. Masson, Paris.

Kuyper, W. 1988. Specific and infraespecific delimitation. in: Bas, C. *et al*. Flora Agaricina Neerlandica, I. Balkema, Rotterdam.

Lonati, G. 2000. Il genere *Crepidotus* in area mediterranea. Mic. Veg. Med. 15: 161-186.

Luther, BS., Redhead SA. 1981. *Crepidotus cinnabarinus* in North America. Mycotaxon 12: 417-430.

Murrill, WA. 1913. The Agaricaceae of tropical North America, VI. Mycologia 5: 18-36.

Murrill, WA. 1917. (Agaricales) Agaricaceae (pars), Agariceae (pars). North Amer. Fl. 10: 145-226.

Murrill, WA. 1940. Additions to Florida fungi, IV. Bull. Torr. Bot. Club 67: 227-235.

Noordelos, ME. 1987. *Entoloma* (Agaricales) in Europe. Beih. Nova Hedwigia 91: 1-419.

Nordstein, S. 1990. The genus *Crepidotus* (Basidiomycotina, Agaricales) in Norway.Synopsis Fungorum 2. Fungiflora, Oslo.

Ortega, A., Buendía AG. 1989. Notas sobre el género *Crepidotus* (Fr.) Staude en España Peninsular. Int. J. Mycol. Lichenol. 4: 93-105.

Peck, CH. 1886. New York species of *Pleurotus*, *Claudopus* and *Crepidotus*. Ann. Rep. N.Y. St. Mus. 39: 58-73.

Peck, CH. 1899. New species of fungi. Bull. Torrey Bot. Club 26: 63-71.

Pegler, DN. 1977. A preliminary Agaric flora of East Africa. Kew Bull. Add. Ser. VI, HMSO, London.

Pegler, DN. 1983. Agaric flora of The Lesser Antilles. Kew Bull. Add. Ser. IX, HMSO, London.

Pegler, DN, Young TWK. 1972. Basidiospore form in the British species of *Crepidotus*. Kew Bull. 27: 311-323.

Pereira, AB. 1990. O genero *Crepidotus* no Rio Grande do Sul, Brasil. Cad. Pesquisa (Bot.) 2: 65-85.

Pilát, A. 1948. Monographie des espèces européenes du genre *Crepidotus* Fr. Atl. Champ. Eur. 6, Praga.

Pilát, A. 1949. Ad monographiam Crepidotorum Europearum supplementum I. Stud. Bot. Ñech. 10: 149-154.

Pilát, A. 1950. Revision of the types of some extra-European species of the genus *Crepidotus* Fr. Trans. Brit. Mycol. Soc. 33: 215-249.

Redhead, SA. 1984. Mycological observations, 4-12: on *Kuehneromyces, Stropharia, Marasmius, Mycena, Geopetalum, Omphalopsis, Phaeomarasmius, Naucoria* and *Prunulus*. Sydowia 37: 246-270.

Senn-Irlet, B. 1995. The genus *Crepidotus* (Fr.) Staude in Europe. Persoonia 16: 1-80.

Senn-Irlet, B., Hofstetter V. 1996. Wie vermögen molekulare daten die klassifikation von *Crepidotus*-arten zu verändern? Mycol. Helvetica 8: 101-107.

Senn-Irlet, B., Krieglsteiner L. 1996. *Crepidotus brunneoroseus*, ein neufund fur Deutschland. Zeit. Mykol. 62: 201-204.

Senn-Irlet, B., De Meijer A. 1998. The genus *Crepidotus* from the state of Paraná, Brazil. Mycotaxon 66: 165-199.

Singer, R. 1947. Monograph of the genus *Crepidotus*. Lilloa 13: 59-95.

Singer, R. 1949. The Agaricales (mushrooms) in modern taxonomy. Lilloa 22: 5-832.

Singer, R. 1953. Type studies on Basidiomycetes, VI. Lilloa 26: 57-159.

Singer, R. 1973. The genera *Marasmiellus, Crepidotus* and *Simocybe* in the neotropics. Beih. Nova Hedwigia 44: 1-484.

Singer, R., 1986. The Agaricales in modern taxonomy. 4ed. Koeltz Sc. Books, Koeningstein.

Singer, R. 1988. Über einige Crepidotaceae. Zeit. Mykol. 54: 69-72.

Stangl, J., Krieglsteiner GJ, Enderle M. 1991. Die Gattung *Crepidotus* (Fr.) Staude 1857 in Deutschland unter besonderer Berücksichtigung Augsburger Funde. Zeit. Mykol. 57: 117 148.

Watling, R., N.M. Gregory, 1989. Crepidotaceae, Pleurotaceae and other pleurotoid agarics. British Fungus Flora 6. Royal Bot. Gard. Edinb.

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New and interesting species of *Russula* from the southeastern United States 1. *Russula billsii*

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Abstract—*Russula billsii* is proposed and described as a new species. This species is closely related to *R. burlinghamiae* and *R. ballouii* from the southeastern United States and *R. viscida* and *R. ochroleuca* from Europe. Information is provided on the ecology, morphology, and anatomy and comparisons are made with related taxa.

Key words—biodiversity, ectomycorrhiza, basidiomycete taxonomy, Russulaceae

Introduction

Species in the genus *Russula* are conspicuous and important mushroom elements in most forest ecosystems. Their ectomycorrhizal habit and importance as a source of food for insects and larger animals has been well documented (Bills, Holtzman & Miller 1986, Villeneuve, Grandtner & Fortin 1989, 1991, Gardes & Bruns 1996, Fogel 1975, Fogel & Trappe 1978). Despite the importance of these fungi, in-depth studies directed explicitly at the Russulaceae mycoflora of many parts of North America are notably lacking. This is especially true for the southeastern United States where no monographic works have been published since the extensive studies of *Russula* from the southern Appalachians by Bills et al. (Bills & Miller 1984, Bills 1984, 1985, 1986, 1989).

The purpose of this paper is to describe one particularly interesting species of *Russula* from the mountains of West Virginia. It is hoped that this paper will rejuvenate studies of the Russulaceae in this important biogeographic region, and that others will make similar taxonomic contributions in the near future.

Materials and Methods

Methods of collection, terminology used, and classification were generally those of Miller, Aime & Henkel (2002). Basidiospore size and shape were determined from optical sections in side view with the apiculus clearly evident and excluding the ornamentation. Color names and descriptions were taken from the Methuen Handbook of Colour (Kornerup & Wanscher 1981); the designations 4A5 refer to Page 4, row A, and color block 5. Spore print colors were compared with the "Code des Couleures de Sporées chez les Russules" found in (Romagnesi 1967). Herbarium names are abbreviated according to Holmgren, Holmgren & Barnett (1990). Dried specimens were examined with standard microchemical reagents useful in the genus.

Taxonomic Description

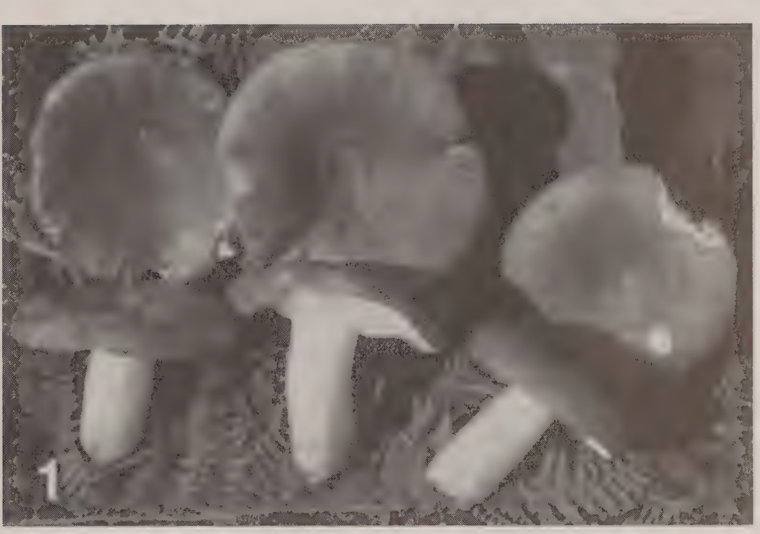
Russula billsii S.L. Mill. FIGURES **1–2, 3–10**

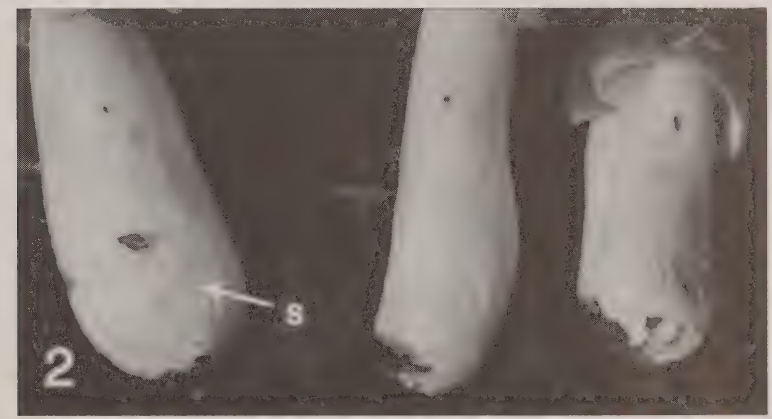
> *Aspectu R. balloui similis, sed illo pileo fusco-rubro granulis, flocculis et pubescentia armeniacis differt. Holotypus hic designatus: West Virginia, Tucker County, Dolly Sods Wilderness Area, 24 August 1984, col. Gerald Bills GB840 (RMS).*
>
> ***Etymology***: Latinized (*billsii*), in honor of Dr. Gerald F. Bills who made a significant contribution to our knowledge of the *Russula* flora of the southern Appalachians.

Pileus 2.2–6.5 (9) cm broad, hemispheric young, then broadly convex to plano-depressed; margin incurved young then plane, finally uplifted, not striate to obscurely striate young, in age obscurely sulcate-striate; cuticle separable 1/3 to 3/4 to disc; surface dry to moist, tacky when moist, not viscid, dull, minutely velutinous to scurfy, with fine aereolate scales that form as granular cuticular fragments toward the margin during pileus expansion, disc smooth with canescent bloom to heavily scurfy, bloom pale greyish yellow, scales and granules bright orange yellow, 4A5–5A6, with cuticle beneath scales dark vinaceous grey 9E5 at disc, shoulders bright red or dark red 9A6–8, 9B6–79C7–8 to reddish brown 9D5–7, greyish red 9C4–6 toward margin fading to light red 9B4–5 at margin of older specimens often with small pale yellow flecks or streaks; trama firm to turgid, up to 4 mm thick at midradius, white with pinkish zone immediately beneath the cuticle, unchanging when cut; odor mild; taste acrid.

Lamellae adnate to slightly notched, close to crowded, forked commonly near stipe and occasionally elsewhere, frequently anastomosing especially in age, lamellulae present at various ranks, often associated with anastomosis, brittle, up to 5 mm broad at midradius, subacute in front, pale yellowish white young then as dark as Romagnesi IIB–C; edges even.

Stipe 3.5–6 cm tall, 1–1.6 cm wide at midpoint, equal or enlarged somewhat at apex or base or constricted midway; surface dry, dull, covered with fine pruinae or aereolate scales, scales aggregated below into distinct bands as a result of outer cuticle fragmentation during stipe expansion, with faint longitudinal rugulose pattern beneath the scales; white to cream white at first, then pale yellow brown, ochraceous-buff near 4–5B5, pale cream or with faint pinkish tint just below the lamellae, scurfy material white at first, discoloring ochraceous-buff where handled; trama stuffed when young, core spongy in age, white, unchanging or discoloring pale brownish-buff when injured.





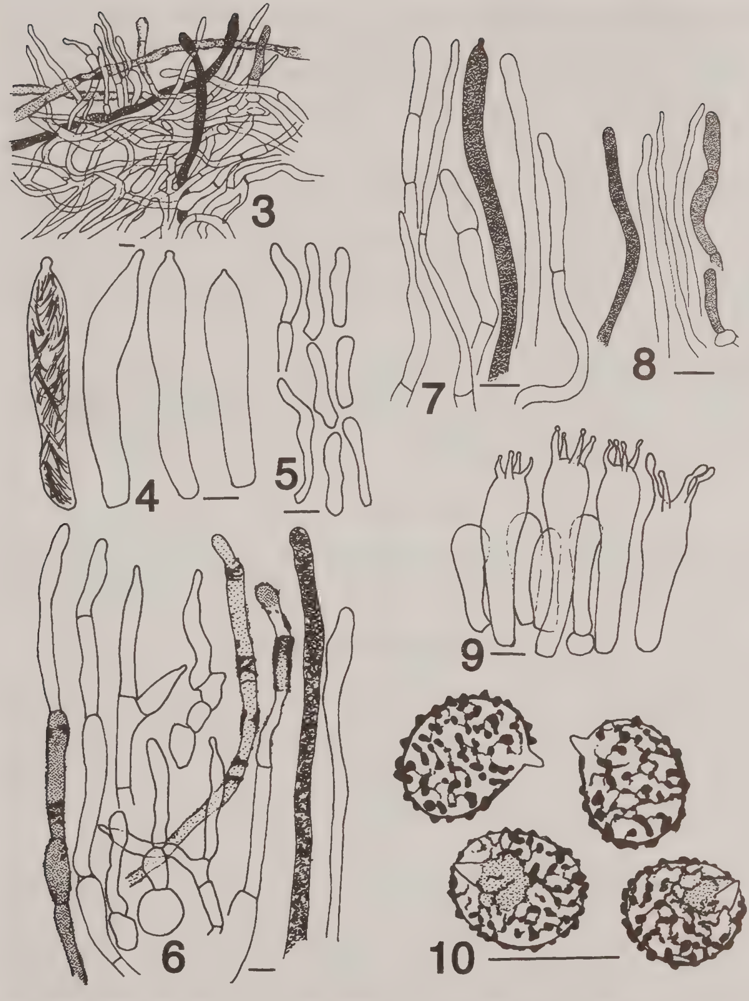
Figs. 1–2. *Russula billsii* (*GB 840*), x 0.5. 2. *Russula billsii* (*GB 840*), x 1.0. The arrow at "s" denotes the scales formed by stretching of the stipe cuticle during expansion of the stipe (photo by Gerald Bills).

Chemical reactions: (stipe trama): formalin-faintly pink, SV-pale pinkish violet, $FeSO_4$- pale pink, phenol-gray maroon, aniline (lamellae)-yellow, to yellowish orange, finally orange with surrounding gray zone after 1 h.

Basidiospores pale yellowish white (Romagnesi IIB–C) in mass, 8–9.6 x 6.4–8 μm, obovate to broadly obovate; ornamentation amyloid, 0.2–1 μm high, consisting of prominent, cylindrical to conical verrucae, short ridges and fine particles, verrucae often aggregated into short catenulate ridges, verrucae and ridges interconnected by low connectives, forming a partial to nearly complete reticulum; suprahilar area often depressed, ornamented with an aggregation of fine amyloid particles or low diffuse patches, sometimes bordered by a line of fine particles, or with fine radiating lines; hilar appendix non-amyloid, conspicuous. **Basidia** 40–52 x 8.8–11.2 μm, clavate to broadly clavate, hyaline to pale yellow in KOH, 4 sterigmate. **Hymenial cystidia** as pleuromacrocystidia and cheilomacrocystidia, 72–110 x 9.6–11.2 μm, cylindrical, narrowly clavate, lanceolate or subventricose, usually with an acute or mucronate apex, occasionally with an amorphous exudation at the apex, grayish brown in SV, hyaline to pale yellow in KOH with crystalline contents, arising from trama, projecting up to 20 μm beyond the basidia, very abundant; **marginal cells** abundant, small, basidiomorphous to often irregularly constricted or swollen or more or less sinuous. **Subhymenium** pseudoparenchymatous, 3–4 cells thick, cells 5–10 μm in diam. **Lamellar trama** composed of sphaerocytes, connective hyphae and laticiferous hyphae and enterocystidia; sphaerocytes 15–30 μm in diam, connective hyphae cylindrical 4–5 μm in diam, laticifers with pale yellow refractive contents in KOH, 5–6 μm in diam, occasionally terminating in enterocystidia with rounded terminus and finely granular contents.

Pileipellis two-layered, not gelatinous; epicutis a trichoderm consisting of erect, tangled hyphae and scattered dermatocystidia frequently aggregated into fascicles or with free ends embedded or agglutinated into a crust-like layer by a yellow to reddish brown incrusting material; epicuticular hyphae septate, branched, 3–5.5 μm in diam, with blunt, undifferentiated ends, hyaline, yellow to reddish brown in KOH or with reddish brown incrustations; incrusting material insoluble in KOH, and ethanol, dark blue orthochromatic in Cresyl Blue and losing color rapidly but remaining heavily incrusted in Basic Fuschin and dilute HCl; dermatocystidia cylindrical to narrowly clavate, with rounded or slightly attenuated apices, 0–2-septate, 25–105 x 3.5–8μm, contents slightly refractive, hyaline to pale yellow in KOH, pale grayish brown in SV, originating from laticiferous system; subcutis composed of interwoven, branched and unbranched hyphae and intermixed laticiferous hyphae; subcuticular hyphae septate, branched, 2–7.5 μm in diam, hyaline in KOH; laticiferous hyphae flexuous, 5–9.5 μm in diam, with yellow refractive contents in KOH, grayish brown in SV. Pileus trama composed of sphaerocytes, connective hyphae and laticiferous hyphae; laticiferous hyphae abundant, 4–10 μm in diam, pale yellow refractive contents in KOH, grayish brown in SV.

Stipe cuticle at the apex composed of erect, suberect or interwoven hyphae and gloeopleurous elements similar to the pileipellis; hyphae septate, branched or unbranched, hyaline or yellow to reddish brown in KOH, 3–9 μm in diam, often incrusted, with hyphal ends often fused into a crust-like layer or filled with dark



Figs. 3–10. Microscopic spore and pellis features of *Russula billsii (GB 840)*. Scale bars = 10 μm. 3. Pileipellis of erect, tangled hyphae and scattered dermatocystidia covered with encrusted often agglutinized hyphae. 4. Pleuromacrocystidia and cheilomacrocystidia. Crystals in cystidium at left are indicative of sulfovanillin staining. 5. Marginal cells. 6. Elements of suprapellis. Note uniformly granular contents of gloeopleurous hyphae, and incrusted hyphae from scurfy or floccose layer of pileus. 7. Caulocystidia and gloeopleurous elements of stipe apex. The three elements mounted in KOH on the right are gloeopleurous hyphae filled with uniformly granular material. 8. Caulocystidia and gloeopleurous elements of scales at the stipe base. The two elements at left are gloeopleurous hyphae mounted in KOH and are filled with uniformly granular material. The two hyphae at right mounted in KOH are filled with uniformly dark yellow brown resinous material. 9. Basidioles and 4-sterigmate basidia. 10. Basidiospores with depressed suprahilar area and low verrucae and connectives, forming a partial to nearly complete reticulum.

yellow brown material similar to pileus cuticle; crust-like layer continuous on young stipe, separating into scales as the stipe expands; elements of the stipe base similar but narrower, hyphae 2–5 μm in diam gloeopleurous elements up to 5 μm diam. Stipe trama consisting of an outer and inner cortex; outer cortex pseudoparenchymatous with abundant laticifers; laticifers 4.5–8.5 μm in diam, with yellow refractive contents in KOH, grayish purple in SV; inner cortex composed of nests of sphaerocytes surrounded by connective hyphae and laticifers.

Clamp connections absent in all tissues.

Habit, habitat, and distribution — Gregarious on soil, in forests dominated by *Tilia heterophylla* L., *Betula lenta* L., *Tsuga canadensis* (L.) Carr, *Betula alleghaniensis* Britton, *Rhododendron maximum* L. Known only from West Virginia; fruiting August to September.

> **MATERIAL EXAMINED—USA. West Virginia: Tucker Co.** G. Bills 840, Red Creek, Dolly Sods Wilderness Area, 2 August 1984 (**Holotype** RMS). **Tucker Co.** G. Bills 839, Dolly Sods Wilderness Area, 2 August 1984 (RMS). **Randolph Co.** C. Ovrebo and N. S. Weber, 2 August 1985 (RMS). **Barbour Co.** Donna Mitchell WV97-9, Laural Mt., 6 September 1997 (RMS).

Discussion

The fine scales, granules and abundant yellow-orange floccules and pubescence on the pileus, the ornamented stipe with basal aereolate scales and basidiospores with verrucae and ridges interconnected by low connectives and forming a partial to nearly complete reticulum indicates a close relationship with *R. ballouii* Peck also found in the southeastern United States (Bills & Miller 1984). These characters also suggest a relationship with *R. viscida* Kudrna from Europe, which has a granulose pileus especially at the disk, but lacks the yellow orange floccules, although a yellow base may be present on the stipe (Kibby 2000, Galli 1966). Kibby (2000) stated that the only species that *R. viscida* could be confused with in Great Britain is *R. atropurpurea* (Kromb.) Britzelm. except that *R. atropurpurea* lacks the yellowish-brown crustose base.

Bills & Miller (1984) followed Singer (1975) in placing *R. ballouii* in subsection Fistulosinae R.Heim because of the strikingly ornamented stipe and the scales and granulose nature of the pileus. They also indicated a close affinity between *R. ballouii* and *R. burlinghamiae* Singer (=*R. insignis* Burl., *non* Quél.) which has recently been recollected and identified from both Costa Rica and the southeastern United States (R. Halling, pers. comm.), and which also has a strongly ornamented pileus and stipe. *Russula billsii* and *R. burlinghamiae* both possess the aereolate to granulose pileus and stipe ornamentation as well as the yellow pubescence on the pileus and often the stipe.

In a molecular analysis of representatives of all infrageneric groups from Europe, Miller & Buyck (2002) found support for a previously undocumented relationship between *R. ochroleuca* (Pers.) Fr., *R. atropurpurea*, and *R. viscida*. These fungi were not related to members of the subsection Fistulosinae. Features of the pileus cuticle and basidiospore ornamentation in *R. billsii*, *R. ballouii* and *R. burlinghamiae* from the southeastern and eastern United States show a great deal of similarity to these European taxa. Sequence data (not shown) for the group also indicates a close relationship between these European and North American taxa. This suggests that stipe and pileus ornamentation, while useful characters for identification of several species in this group, are not unifying characters at the infrageneric level.

The placement of *R. billsii* and related species in an infrageneric classification scheme is somewhat difficult at the present time. *Russula atropurpurea*, *R. ochroleuca* and *R. viscida* have each been placed in separate subgenera, sections or subsections by previous experts on European *Russula* taxonomy (Romagnesi 1967, Singer 1986, Sarnari 1998). Peck (1913) did not explicitly place *R. ballouii* in a specific infrageneric group at the time of his original description. Burlingham (1915) placed her *R. insignis* (=*R. burlinghamiae* Singer) and *R. ballouii* together in section Insignes along with several other species because they possessed a yellowish stipe "adorned, at least below, with deeper yellow granules or squamules." She found no relationship with either *R. atropurpurea*, which she placed in section Atropurpureae, or *R. ochroleuca*, which she placed in the section Ochroleucae. Because not all species related to *R. billsii* share the features of ornamented pileus or stipe or the yellow floccules or pubescence, and several additional related neotropical and temperate species are in need of critical examination, it is perhaps best to hold off on the creation and formal validation of a new section or subsection at this time.

Acknowledgements

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Literature Cited

Bills GF 1984. Southern Appalachian Russulas. II. Mycotaxon 21: 491-517.
Bills GF 1985. Southern Appalachian Russulas. III. Brittonia 37: 360-365.
Bills GF 1986. *Russula vesicatoria* and *Russula angustispora sp. nov.* two confusing species of *Russula* subsection *Lactarioideae*. Mycotaxon 25: 607-620.
Bills GF 1989. Southern Appalachian Russulas. IV. Mycol. 81: 57-65.
Bills GF, Miller Jr OK. 1984. Southern Appalachian Russulas. I. Mycol. 76: 975-1002.
Bills GF, Holtzman GI, Miller Jr OK. 1986. Comparison of ectomycorrhizal basidiomycete communities in red spruce *versus* northern hardwood forests of West Virginia. Canad. J. Bot. 64: 760-768.
Burlingham GS. 1915. *Russula*. North American Flora 9: 201-236. New York Botanic Garden. New York.
Fogel R. 1975. Insect mycophagy: a preliminary bibliography. USDA Forest Service General Technical Report PNW-36. Pacific Northwest Forest and Range Experiment Station Portland Oregon. 21 pp.
Fogel R, Trappe JM. . 1978. Fungus consumption (mycophagy) by small animals. Northwest Sci. 52: 1-31.
Galli R. 1966. *Le russule*. Ednitura Edizioni Naturalistiche Milan.
Gardes M, Bruns TD. 1996. Community structure of ectomycorrhizal fungi in a *Pinus muricata* forest: above- and below-ground views. Canad. J. Bot. 74: 1572-1583.
Holmgren P, Holmgren N, Barnett LC. 1990. Index Herbariorum part I. *The Herbaria of the World.* Regnum Veg. 120: 1-693.

Kibby G. 2000. Fungal Portraits no. 3. *Russula viscida*. Field Mycology 1: 75-76.

Kornerup A, Wanscher JH. 1981. *Methuen Handbook of Colour*. 3rd ed. Eyre Methuen London 252 p.

Miller SL, Aime MC, Henkel TW. 2002. Russulaceae from the Pakaraima Mountains of Guyana. I. New species of pleurotoid *Lactarius*. Mycol. 94: 545-553.

Miller SL, Buyck B. 2002. Molecular phylogeny of the genus *Russula* in Europe with a comparison of modern infrageneric classifications. Mycol. Res. 106: 259-276

Peck CH. 1913. Report of the State Botanist 1912. New York State Mus. Bull. No. 167: 31.

Romagnesi H. (1967. *Les Russules d'Europe et d'Afrique du Nord*. Bordas Paris.

Sarnari M. 1998) *Monographia illustrata del genre Russula in Europa*. Trento Italy: Associazione Micologica Bresadola.

Singer R. 1975. The Agaricales in modern taxonomy. 3rd ed. J. Cramer, Vaduz.

Singer R. 1986. *The Agaricales in Modern Taxonomy*. 4th edn. Koeltz Scientific Books Koenigstein Germany.

Villeneuve N, Grandtner MM, Fortin JA. 1989. Frequency and diversity of ectomycorrhizal and saprotrophic macrofungi in the Laurentide Mountains of Quebec. Canad. J. Bot. 67: 2626-2629.

Villeneuve N, Grandtner MM, Fortin JA. 1991. The coenological organization of ectomycorrhizal macrofungi in the Laurentide Mountains of Quebec. Canad. J. Bot. 69: 2215-2224.

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Suttoniella arnaudii sp. nov. (Coelomycetes) on dead leaves of *Buxus sempervirens*

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Abstract–A new species *Suttoniella arnaudii* (Coelomycetes) is recorded from Catalonia, in northeastern Spain, on dead leaves of *Buxus sempervirens*. This is the first report of the genus *Suttoniella* in Europe. *S. arnaudii* is characterized by large pycnidia and conidiogenous cells, and short secondary arms of the conidia. A key to *Suttoniella* species is provided.

Key words – taxonomy, saprotrophic fungi, triradiate conidia

Introduction

Since 1994 the first author (PH) has been studying the fungi that grow on *Buxus sempervirens* L. in Catalonia (Muntañola-Cvetković et al. 2001). We have found, on fallen leaves of this plant, a fungus which resembles that drawn by Arnaud (1954). It was identified as *Blennoria buxi* Fr. Arnaud gave no description of the fungus, but indicated that it was found on *Buxus* from Montpellier (France). Sutton (1972) rectified the identification of *B. buxi* by Arnaud (1954) and concluded that it belonged to the genus *Suttoniella* Ahmad. Sutton tried to inspect Arnaud's material, but it was not found in the Arnaud herbarium. In any case, Sutton (op. cit.) commented that, of the two species of *Suttoniella* described until then, Arnaud's material came closer to *S. eriobotryae* (Ahmad) Ahmad because of the size of the conidia. However, in *S. eriobotryae* the arms of the conidia are tapered towards the apices, whereas in Arnaud's drawings they are cylindrical and obtuse at the apices (Sutton, op. cit.).

On the basis of Arnaud's drawing and our collections, we propose a new species of *Suttoniella*, and a key to species of *Suttoniella*.

Materials and Methods

Eighty-eight sites in Catalonia (Spain) have been prospected since October 1994, in all seasons of the year. Dead leaves were inspected immediately for fungal structures, or air-dried for further study. Air-dried samples were incubated in moist chambers for 1-9 days before examination. The specimens were examined with a binocular dissecting microscope (Olympus SZH10) and a Leitz Diaplan microscope with DIC (differential interference contrast) optical systems. Hand-cut sections of the material were mounted in water or in lactophenol-fuchsin. All measurements were made in water. The 95% confidence intervals were derived from 30 conidia and 10 conidiogenous cells measured to determine the range of variation in size of these cells, with the extremes given in parenthesis. Voucher specimens are kept at BCN-Myc. (Barcelona Herbarium).

Taxonomy

Suttoniella arnaudii Hoyo & Gómez-Bolea, **sp. nov.** (Fig. 1 and 2)
Etym.: the species is named after Gabriel Arnaud (1882-1957), a French mycologist who was the first author to observe it.

> *Pycnidia amphigena, sejuncta, ovalis vel polygonalis (triangularia, tetrangularia, pentangularia), coriacea, anthracinea, initialiter subepidermalia, postea erumpentia, usque ad 3000 µm diam., fissura transversale vel triradiata, tetraradiata, pentaradiata dehiscentia. Stratum basale pycnidii 47-52 µm altum, hialinum vel pallide brunneum cellulis pseudoparenchymatis efformatum et strato hypharum verticalium superatum, cujus cellulae ultimae conidiogenae. Tectum pycnidii cellulis parvis brunneis pseudoparenchymatis, parietibus crassis compositum. Cellulae conidiogenae hyalinae, oblongus, polyblasticae, 17-23 x 9-12.5 µm. Conidia blastica, solitaria, ramosa, duobus brachiis primariis cellula basale junctis et quatuor brachiis secundariis binatim brachiis primariis insitis, compositus. Cellula basali hyalina, non-septata, laevia, furcata, 5.9-6.3 x 1.8-2 µm. Brachii primaria hyalina, non-septata, laevia, cylindrica, (15-)17-20 x 2.5-3.5 µm. Brachia secundaria divergentia, hyalina, non-septata, laevia, cylindrica, ad extremitatem rotundata, 15-20 x 2.5-3.2 µm, primariis constrictione angusta nexa. Brachia primaria cum brachiis secundariis ad maturitatem a cellula basali separata.*

Holotype: Spain: Catalonia: Barcelona: 2 Km from Olesa de Bonesvalls on the road to Vallirana, alt. 350 m, U.T.M.: 31TDF0579, on leaf litter of *B. sempervirens*, 7 June 2003, *J. A. Ramírez* and *P. Hoyo*, (BCN-Myc. HOYO-322).

Pycnidia amphigenous, isolated, oval or polygonal (triangular, tetrangular, pentangular), coriaceous, glossy black, initially subepidermal, later erumpent, up to 3000 µm in diameter, dehiscing by transverse fissure or a triradiate, tetraradiate or pentaradiate fissure. *Basal stratum* of pycnidium 47-52 µm high, hyaline to pale brown, pseudoparenchymatous cells surmounted by a layer of vertical hyphae, with ultimate cells conidiogenous. *Roof of pycnidium* composed of small, brown, thick-walled pseudoparenchymatous cells. *Conidiogenous cells* hyaline, oblong, polyblastic with 1-5 apertures, 17-23 x 9-12.5 µm. *Conidia* blastic, solitary, branched, composed of two primary arms linked to a common basal cell and four secondary arms, two per each primary arm. Basal cell hyaline, non-septate, smooth, forked, 5.9-6.3 x 1.8-2 µm. Primary arms hyaline, non-septate, smooth, cylindrical, (15-)

17-20 x 2.5-3.5 µm. Secondary arms divergent, hyaline, non-septate, smooth, cylindrical, rounded at the distal end, 15-20 x 2.5-3.2 µm, connected by a narrow constriction to the primary arm. Primary arms along with their respective secondary arms getting detached from the basal cell at maturity.

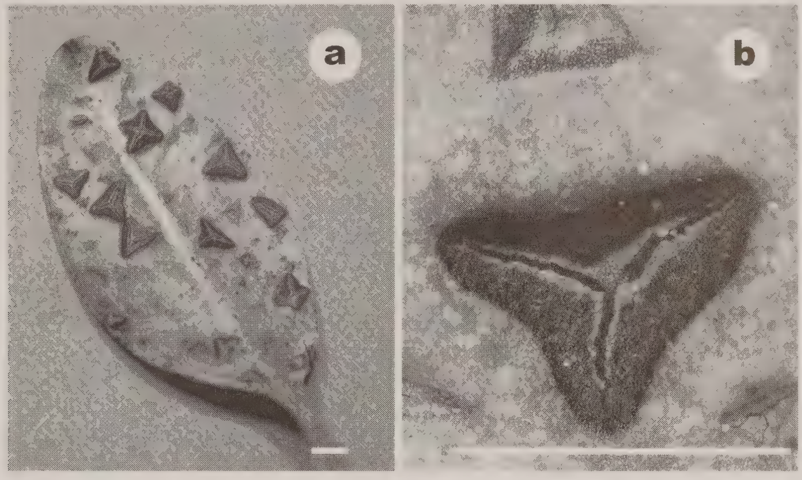

Fig. 1. *Suttoniella arnaudii* (Holotype BCN-Myc. HOYO-322). a.- Pycnidia on a *B. sempervirens* leaf. b.- Detail of a pycnidium. Scale Bars = 1,7 mm.

Ecology and distribution: *S. arnaudii* has been found at 8 localities in Catalonia (Spain) and from Montpellier (France) (Arnaud 1954). It grows on fallen leaves of *B. sempervirens*, at altitudes between 350 – 800 m. We found *S. arnaudii* only where *B. sempervirens* grows in the mediterranean region of Catalonia. *Suttoniella arnaudii* occurs together with *Microthyrium macrosporum* (Sacc.) Höhnel and, more rarely, with *Blennoria buxi*, *Botryosphaeria* sp., *Chaetopsina* cf. *fulva* Rambelli, *Dothiorella candollei* (Berk. & Br.) Petrak, *Gibberella buxi* (Fuckel) Winter and its anamorph *Fusarium lateritium* (Nees) emend. Snyder et Hansen var. *buxi* Booth, *Gyrothrix circinata* (Berk. & Curt.) Hughes, *Marasmius buxi* Fr. in Quél., *Pseudonectria coronata* (Juel) Lowen and its anamorph *Sesquicillium buxi* (J. C. Schmidt) W. Gams, and *Pyrenochaeta ilicis* M. Wilson. Well sporulated conidiomata were found from March to June. Material collected between December and February formed conidia after 1-9 days of incubation in a moist chamber. However, material collected between September and November, and submitted to the same treatment, did not form conidia.

ADDITIONAL SPECIMENS EXAMINED – SPAIN. CATALONIA: **Anoia**, Castellolí, in the Bruc tunnel, 31TCG9405, alt. 600 m, 5 May 2003, *R. Quadrada*, (BCN-Myc. Hoyo-288). **Mediona**, Obaga de Rofes, 31TCF8294, alt. 670 m, 30 November 2002, *P. Hoyo* (BCN-Myc. Hoyo-208). **Bages**, Balsareny, 31TDG0635, alt.

400 m, 3 May 2003, *P. Hoyo* and *J.A. Ramírez* (BCN-Myc. Hoyo-287). **Berguedà**, Borredà, Cobert de Puigcercós, 31TDG2165, alt. 800 m, 19 October 2002, *P. Hoyo*, (BCN-Myc. Hoyo-192). Ibidem. *P. Hoyo*, *A. Longán* and *E. Llop*, 28 February 2003 (BCN-Myc. Hoyo-259, 260, 262 and 266). **Osona**, Orís, 31TDG3459, alt. 575 m, 28 September 2002, *P. Hoyo* (BCN-Myc. Hoyo-183). Ibidem. *E. Llop*, *P. Hoyo* and *A. Longán*, 28 February 2003 (BCN-Myc. Hoyo-267, 268 and 286). Ibidem. *J.A. Ramírez* and *P.Hoyo*, 31 May 2003 (BCN-Myc. Hoyo-321). **Osona**, Seva, 13,5 Km road to Viladrau, 31TDG4332, alt. 740 m, 9 March 2003, *P. Hoyo* (BCN-Myc. Hoyo-323).- Ibidem. *P. Hoyo*, 26 April 2003 (BCN-Myc. Hoyo-318). **Osona**, 3 Km to Sora, 31TDG3263, alt. 720 m, 31 May 2003, *P.Hoyo* and *J.A. Ramírez* (BCN-Myc. Hoyo-320).

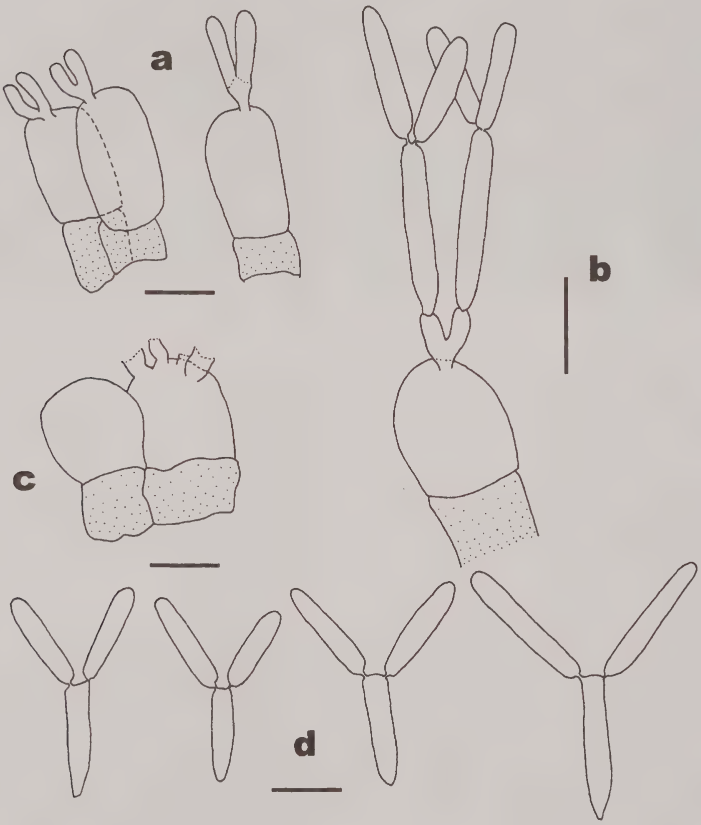

Fig. 2. *Suttoniella arnaudii* (Holotype BCN-Myc. HOYO-322). a-b.- Stages in the development of conidia. c.- Conidiogenous cells. d.- Conidia. (Scale Bars = 10 µm).

Discussion

Pseuderiospora Petrak was the genus proposed for the new species *P. gaubae* (Petrak 1959). Ahmad (1960a) pointed out that the generic name *Pseuderiospora* Petrak is a later homonym of *Pseuderiospora* Keissler published in Anzeiger Akad. Wiss Wien nr. 11, p. 75, and consequently he proposed the new name *Suttonia*, in honour of B.C. Sutton. The same author changed the generic name *Suttonia* to *Suttoniella*, because his original name was already occupied by *Suttonia* A. Rich., 1832 (Myrsinaceae) (Ahmad 1960b). Consequently, the species typus must be named *Suttoniella gaubae* (Petrak) Ahmad. The key features of the genus *Suttoniella* are the gross pycnidia, the poliblastic conidiogenous cells and the armed conidia. Subramanian & Sudha (1979) were the first authors to describe correctly the conidial ontogeny of *Suttoniella* species. They are formed by three parts: a) basal cell bifurcated distally and with a truncate base; b) two primary arms distally supported by the basal cell, one in each bifurcation, and c) four divergent secondary arms, two on each primary arm. The hitherto known species of the genus *Suttoniella* are: *S. gaubae*, *S. eriobotryae* and *S. ixorae* Subram. & Sudha. *S. gaubae* was originally described from Kangaroo Island (South Australia) on *Alyxia buxifolia* R. Br. (Petrak 1959). *S. eriobotryae* was originally described from Choa Saidan Shah (West Pakistan) on fallen leaves of *Eriobotrya japonica* (Thunb.) Lindl (Ahmad 1960a). *S. ixorae* was originally described from Tambaram, Madras (India) on leaf litter of *Ixora parviflora* Vahl. (Subramanian & Sudha 1979).

S. arnaudii differs from the remaining *Suttoniella* species in having has larger pycnidia and conidiogenous cells, and shorter secondary arms of the conidia. Comparative main features are summarised in Table 1 and a key to identify *Suttoniella* species is given below. In *S. arnaudii* the basal cell of conidia is ephemeral, and it leaves two dispersion units in a Y-shape. The time of maturation of the conidia is very short. In a moist chamber, no basal cells can be observed after 7 h and only the dispersion units are visible.

Key to Suttoniella species

1 Pycnidia more than 1500 µm wide. Conidia with primary arms (15-)17-20 x 2.5-3.5 µm and secondary arms 15-20 µm long............... ***S. arnaudii***

1’ Pycnidia up to 1500 µm wide, conidial arms otherwise....................................... 2

2 Primary arms 4.5-5 µm wide.. ***S. eriobotryae***

2’ Primary arms up to 3.5 µm wide... 3

3 Secondary arms (26-)32-43(-50) µm long.. ***S. gaubae***

3’ Secondary arms 20-27 µm long.. ***S. ixorae***

Table1. Comparative main features extracted from the protologues.

	S. gaubae (Petrak 1959)	*S. eriobotryae* (Ahmad 1960a)	*S. ixorae* (Subramanian & Sudha 1979)	*S. arnaudii*
Pycnidia	(300-)500-800 (-1000) µm, orbicular to elliptic, dehiscing by irregular fissures spreading from the centre	625-875 µm, elliptic	900-1200 µm, triangular, oblong to round, dehiscing by a transverse slit or a triradiate fissure	Up to 3000 µm, oval or polygonal, dehiscing by irregular fissures (1-)3 (-5) spreading from the centre
Basal stratum	(12-)15 (-20) µm	50-100 µm	—	47-52 µm
Conidiogenous cells	—	5-10 x 5-15 µm	14-18.5 x 7.8-8 µm, hyaline at first, later brown, cylindrical, polyblastic	17-23 x 9-12.5 µm, hyaline, oblong, polyblastic
Conidia: Primary arms	(12-)15(-20) x 2.5-3.5 µm	13.5-25 x 4.5-5 µm	18.7-24.5 x 2.6-3.3 µm, cylindrical	(15-) 17-20 x 2.5-3.5 µm, cylindrical
Conidia: Secondary arms	(26-)32-43 (-50) x 2.5-3.5 µm	20-30 x 4.5 µm	19.9-27 x 2.4-3 µm, cylindrical, rounded at the distal end	15-20 x 2.5-3.2 µm, cylindrical, rounded at the distal end
Substrate / Distribution	Leaves of *Alyxia buxifolia*. Australia	Leaves of *Eriobotrya japonica*. Pakistan	Leaf litter of *Ixora parviflora*. India	Dead leaves of *Buxus sempervirens*. Spain

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Literature Cited

Ahmad S. 1960a. Further contributions to the fungi of West Pakistan, I. Biologia, Lahore 6: 117-136.

Ahmad S. 1960b. Further contributions to the fungi of West Pakistan, I. Some corrections. Biologia, Lahore 6: 257-258.

Arnaud G. 1954. Mycologie concrète: genera II (suite et fin). Bulletin de la Société Mycologique de France 69: 265-306.

Muntañola-Cvetković M., Hoyo P., Sierra D. & Llimona X. 2001. Lesions i estructures fúngiques en arbustos espontanis de Catalunya. II. Sobre fulles i branquillons de *Buxus sempervirens*. Revista Catalana de Micologia 23: 127-143.

Petrak F. 1959. *Pseuderiospora* n. gen., eine neue, staurospore Gattung der Sphaeropsideen. Sydowia 13: 109-112.

Subramanian C.V. & Sudha K. 1979. *Suttoniella ixorae* sp. nov. Kavaka 7: 87-92.

Sutton B.C. 1972. *Wakefieldia punctata* Arnaud and *Blennoria buxi* Fr. sensu Arnaud. Transactions of the British Mycological Society 59: 285-294.

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Lactarius subgenus *Piperites*: a new species and a new name

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Abstract—Two members of *Lactarius* subgenus *Piperites* were studied. *Lactarius miniatosporus* corresponds to a new species in section *Dapetes*, found in association with *Pinus* in the central region of the Gulf area of Mexico. It is compared with its close relatives, *L. subpurpureus* from the U.S., *L. thakalorum* from Nepal and the European *L. sanguifluus*. A type study revealed that morphocharacters of the U.S. variety *Lactarius scrobiculatus* var. *pubescens* (section *Crocei* subsection *Scrobiculati*) exclude its placement under *L. scrobiculatus*. We propose a new rank and the new name, *L. smithii* for this taxon.

Keywords—*Russulales*, taxonomy, ectomycorrhizal fungi

Introduction

Most species in *Lactarius* subgenus *Piperites* (Fr.) Kauffman, section *Dapetes* Fr. and those in section *Crocei* Hesler & A.H. Sm. (subsection *Scrobiculati* Hesler & A.H. Sm.) presently known from Mexico occurs in coniferous forests. Nearly half of the described species of *Pinus* in the world occur in that country (Styles 1993). This genus can be recognized as the main element that influences the distribution of populations of these groups of *Lactarius*, affecting the presence in Mexico of several *Lactarius* species known to occur (Hesler and Smith 1979) in the U.S. and Canada. For example *Lactarius paradoxus* Beardslee & Burl. (section *Dapetes*) has been recorded from Canada (Lamoureux and Neumann 1991), and the U.S. (Beardslee & Burlingham 1940; Hesler and Smith 1979; Bessette *et al.* 1997), to Eastern Mexico and as far as the Caribbean (Montoya *et al.* 1998).

In this paper a new *Pinus* associated species of *Lactarius* is described and a new status at specific level for the North American *L. scrobiculatus* var. *pubescens* A.H. Sm. is proposed.

Materials and Methods

Macroscopic features were recorded from fresh material; colors indicated in alphanumeric designations are from Kornerup and Wanscher (1978). The methods followed for the microscopic study are those cited by Montoya and Bandala (2003). The following notations are used in the text: **RM** = range of mean values of basidiospore of length x width; **Q** = range of mean values of coef. Q (length/width ratio of spores) (based on 30 basidiospore measurements in each collection). Herbarium acronyms are according to Holmgren *et al.* (1990).

Taxonomic Description

Lactarius miniatosporus Montoya et Bandala *sp. nov.* **FIGURES 1 a-e, 2 a-b**

> *Pileus 40-110 mm latus, convexus, plano-convexus, demum depressus, azonatus vel subzonatus, viscidus, subroseus versus rubellus vel subroceo vinaceo pallidus, luteus decolorans; margine valde subroseo rubellus, striato, incurvato. Lamellae subdecurrentes, moderate distantes, vinaceo pallidus. Stipes 15-70 x (8-) 10-20 mm, cilindricus, sordidus subroseus vel subroseo vinaceus. Caro alba, rubescens. Sporae 6.4-8 (-8.8) x 4.8-6.4 (-7.2) µm, ellipticae, sub-reticulatae vel reticulatae, ornamentum 0.6 (-0.8) µm altis. Pleurocystidia absentia. Cheilocystidia 28-48 x 5.6-6.4 µm, sub-fusiformia. Pileipellis ixocutis, hyphis filiformis instructa. HOLOTYPUS: lectus prope MEXICO. VERACRUZ: Mpio. Xico, E Cofre Perote, Ejido Ingenio El Rosario, El Revolcadero, 3.VII.2002, Montoya 3830 (XAL).*

Pileus 40-110 mm wide, convex to plano convex, centrally depressed, azonate or with diffuse and vanishing zonations, viscid, pinkish with pale reddish tinges to pale pinkish-vinaceous (7A2-B3, 8A2-B2), with dark pinkish-vinaceous stains (8C5-D5), fading to straw color or yellowish white (4A2-5A2-A3-B2-B4), then often the margin retains the vinaceous-pink or red-vinaceous color (10B8-C8-D8), and the disc remains dull yellowish-white only with pale pinkish tinges, irregularly staining blue-green (25D3-25E8); margin incurved, edge tomentous in young stages, expanded, glabrous and striate in age. **Lamellae** adnate to subdecurrent, subventricose, dichotomous towards the stipe attachment, close to moderately subdistant, 3-9 mm broad, with lamellulae of different length, pinkish-gray (7B3-B4, 8B2-B3) or vinaceous-red in mass, a single lamella more or less pale pink-vinaceous (10C5), staining blue-green (25D3-25E8) when handled; cut areas staining red-vinaceous by the latex. **Stipe** 15-70 x (8-) 10-20 mm, cylindric, smooth, dry, very rarely superficially spotted, dull pink (8A2-B3) to vinaceous-pink (7B3-8A2-C4-C5, 9B4-10B3) or at times vinaceous-red (10C-D5), whitish and subtomentose at the apex, staining blue-green (25D3-E8). **Context** whitish, staining pink (5A2, 7A2-8A2) when exposed, more evident towards the margin of both pileus and stipe, staining vinaceous-red by the latex and staining blue-green (25D3-D4-E8) in all parts. **Odor** mild or of chlorine. **Taste** mild or faintly astringent. **Latex** vinaceous-red (8C7-D7, 9E7-E8), unchanging. **Spore print** pale yellowish-brown.

Basidiospores 6.4-8 (-8.8) x 4.8-6.4 (-7.2) µm, **RM** = 7-8 x 5.5-6.4 µm, **Q** = 1.2-1.3, broadly ellipsoid, ornamented with a partial to complete reticulum, 0.6 (-0.8) µm high; under SEM the ornamentation appears as continuous interconnected ridges forming an incomplete to complete reticulum; isolated warts also present; bands with an irregular and sinuous margin. **Basidia** 49-74 x 8-9.6 µm, clavate, tetrasporic and bisporic. **Pleurocystidia** absent. **Pseudocystidia** filamentous, 4-4.8 µm wide. **Cheilocystidia** 28-48 x 5.6-6.4 µm, subfusiform, ventricose, sinuous; apex pronounced and often constricted, with refringent contents, infrequent. **Pileipellis** an ixocutis, 96-240 µm wide; hyphae 3.2-5.6 µm wide. **Context** hyphae 4.8-7.2 µm wide; laticifers 8-9.6 µm wide; sphaerocytes 28-36 µm wide. **Hymenophoral trama** hyphae 4-6.4 µm wide; laticifers 5.9-7.2 µm wide, with some sphaerocytes distributed towards the upper third of the lamellae.

Habitat — In the ground, gregarious, associated with trees of *Pinus* in pure or mixed forests of *P.nubicola* Perry, *P. pseudostrobus* Lindl. and *P. patula* Schlecht. & Cham.

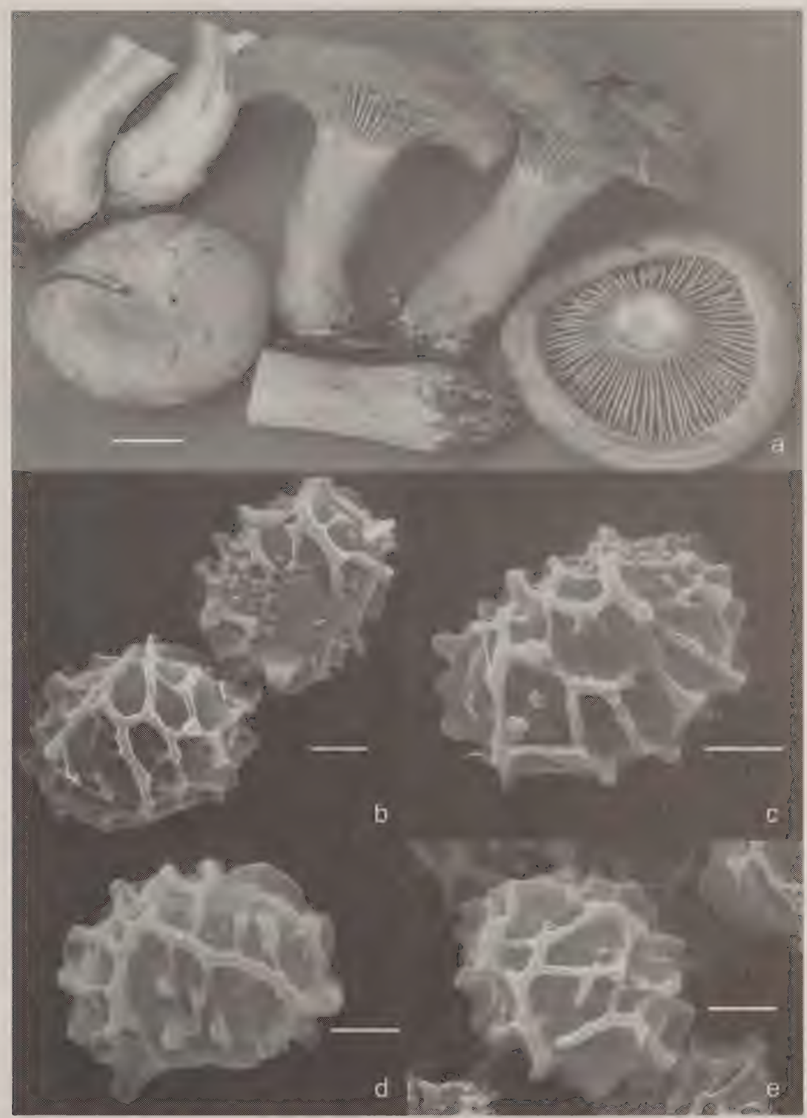

Fig. 1. ***Lactarius miniatosporus*** a. basidiomes (*Montoya 3803*). b-e. basidiospores under SEM (HOLOTYPE). (scale bar = 2 µm, except a = 15 mm).

SPECIMENS EXAMINED. MEXICO — VERACRUZ: **Mpio. Xico**, E Cofre Perote, Ejido Ingenio El Rosario, El Revolcadero, 7.VII.1995, *Montoya 3204*, *3205*; 11.VII.1995, *Montoya 3210*; 12.VII.1995 *Montoya 3211*; 3.VII.2002, *Montoya 3830* (HOLOTYPE). **Mpio. Xalapa**, km 2.5 old road from Xalapa

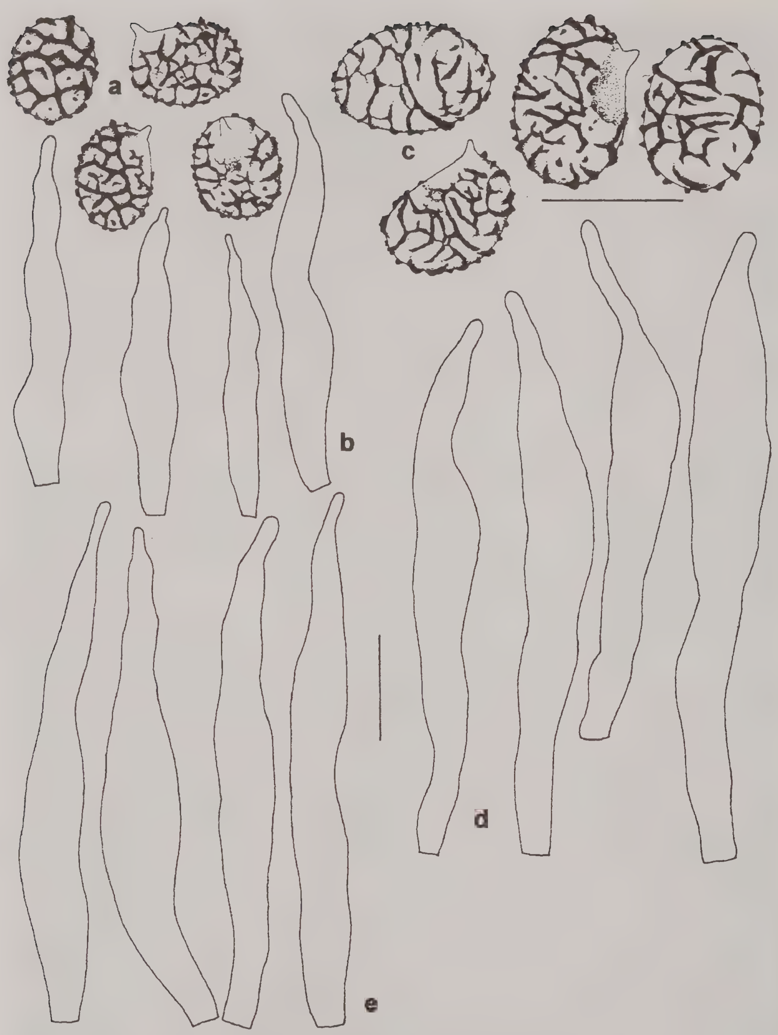

Fig. 2. ***Lactarius miniatosporus*****.** a: basidiospores, b: cheilocystidia (HOLOTYPE). ***L. subpurpureus*****.** c: basidiospores, d: pleurocystidia, e: cheilocystidia (HOLOTYPE). (scale bar = 10 µm).

to Coatepec. Botanical Garden, 26.VI.2002, *Montoya 3803*; 1.VIII.2002, *Montoya 3872*; 4.IX.2002, *Montoya 3908*; 27.IX.2002, *Montoya 3923*; 20.VI.2003 *Montoya 3990* (all in XAL).

OTHER SPECIMENS EXAMINED — ***Lactarius subpurpureus*** Peck. **UNITED STATES**. **N.Y.**: Sandlake & Brewerton, Oct., *Ch. Peck* (HOLOTYPE, NYS). **MICHIGAN**: **Marquette Co.**, Canyon Lake area, 29.VIII.1970, *Harrison 9514* (MICH). ***Lactarius sanguifluus*** var. ***violaceus*** (Barla) Basso. **SPAIN**. **BARCELONA**: Cantonigros Region, 15.X.1996, *Montoya 3409* (XAL). ***Lactarius thakalorum*** Bills & Cotter. **NEPAL**. **DHAULAGIRI**: Mustang Dist., *V. Cotter 1313* (HOLOTYPE, BPI).

Comments — The basidiospore size and absence of pleurocystidia are distinctive when comparing *Lactarius miniatosporus* with other species having basidiomes and latex with vinaceous colors. The periodical monitoring of the populations from Xalapa growing under *Pinus nubicola*, revealed that the variation of pileus color includes a typical tendency to become duller in advanced stages, with the pileus straw color or yellowish-white, and with vinaceous pigmentation only observed at the margin. It is uncommon to observe specimens with the whole pileus uniformly pinkish-vinaceous. Most collections exhibited an azonate pileus or only at times having obscure zonations. In old basidiomes the margin is often striate. These features together with the smooth stipe surface, and blue-green staining of the basidiomes represent a reliable set of macrocharacters to recognize this species in the field.

Lactarius subpurpureus is superficially similar with regard to the basidiome and latex color. Hesler and Smith (1979) reported it with darker basidiomes (dark vinaceous-red, zoned with paler colors) and deep vinaceous-red latex. These authors also recorded for *L. subpurpureus* a cream colored spore deposit. According to American specimens studied, it differs also on having consistently larger basidiospores [(9.6-) 10.4-12 x 7.2-8.8 µm, 11 x 8 µm on avg., with **Q** = 1.4 in the holotype (fig. 2 c, 3 a-b); 9.6-11.2 (-12) x 7.2-8 µm, 11 x 7 µm on avg., **Q** = 1.4 in *Harrison 9514*]. Furthermore, the presence of pleurocystidia distinguish it [44-61.6 x 6.4-8 µm in the holotype (fig. 2 d); 40.4-76.4 x 6.4-9.6 µm in *Harrison 9514*].

Another related species is *Lactarius thakalorum*. According to the protologue (Bills and Cotter 1989), and the study of the type specimen, we conclude that it is distinct from the Mexican taxon by its closer lamellae, presence of pleurocystidia (40-55 x 4-10 µm) and larger basidiospores (8-9.6 x 6.4-7.2 µm, 9 x 7 µm on avg., **Q** = 1.3).

The European *Lactarius sanguifluus* (var. *sanguifluus* and var. *violaceus*) presents another combination of characters, although it is superficially similar to *L. miniatosporus*. The more constantly zonate pileus and scrobiculate stipe, together with pleurocystidia in the European taxon distinguish it. Furthermore, var. *violaceus* has basidiospores 7.2-9.6 x 6.4-8 µm, 9 x 7 µm on avg. (in *Montoya 3409*) or 8-10 x 6.5-7 µm (Basso 1999); and in var. *sanguifluus* they are 7.9-9.5 x 6.3-8 µm, 8-8.8 x 7.1-7.4 µm on avg. (Heilmann-Clausen et al. 1998) or 7.2-9 (-10) x 6-7 µm (Basso 1999).

Lactarius smithii Montoya et Bandala ***nom. nov.*** **FIGURES 3 c-d, 4 a-c**

Basionym: *Lactarius scrobiculatus* var. *pubescens* A.H. Sm., *Brittonia 12*: 323 (1960).
HOLOTYPE: **UNITED STATES. MICHIGAN: Luce Co.**, Taquahmenon Falls State Park, 7.IX.1951, *A.H. Smith 38436* (MICH).

The sharp differences found between the type specimen and *Lactarius scrobiculatus* (Scop.: Fr.) Fr. justify the segregation of the American taxon as an isolated species. For macro- and microscopical details see Hesler and Smith (1960, 1979). Microscopic description below is based on the re-examination of the holotype:

Basidiospores 6.4-8 x 4.4-5.2 (-5.6) µm, 7 x 5 µm on avg; **Q** =1.5; ellipsoid, with the hilar appendix more or less obliquely disposed; ornamentation 0.6 (-0.8) µm high, forming a nearly complete reticulum, with a moderately fine mesh net; under SEM the reticulum is formed of continuous bands, these with a more or less regular margin or somewhat undulate at fused areas, at times with free extremes. **Basidia** 48-60 x 5.6-8 µm,subclavate, tetrasporic

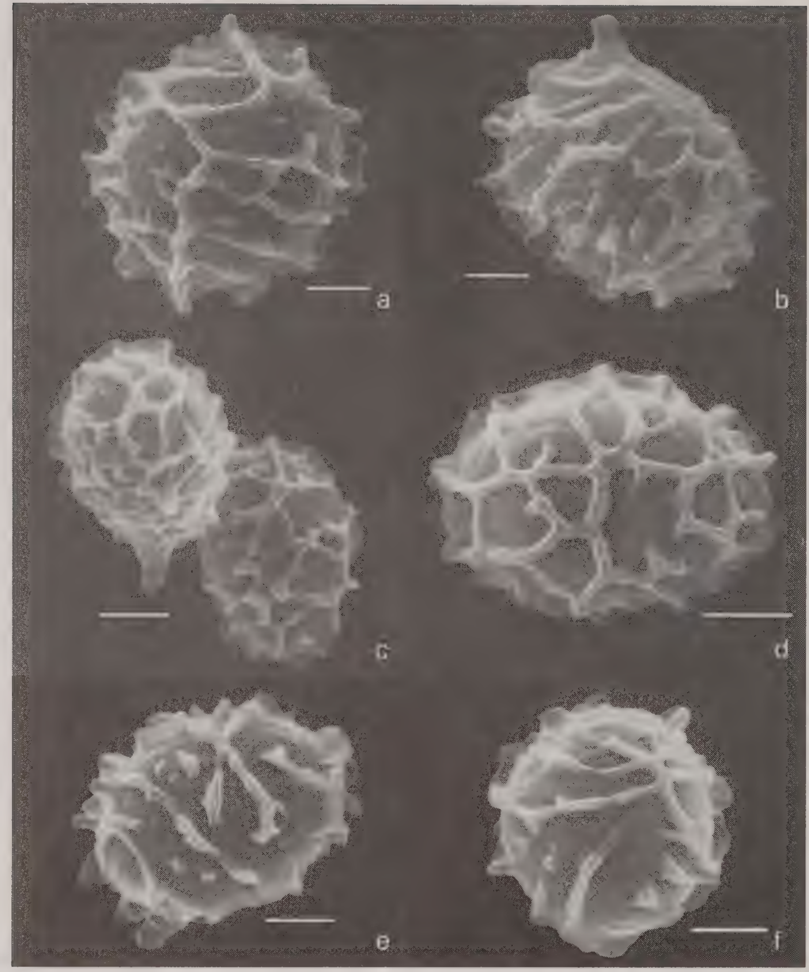

Fig. 3. Basidiospores under SEM. a-b: ***Lactarius subpurpureus*** (HOLOTYPE). c-d: ***L. smithii*** (*A.H. Smith 38436*). e-f: ***L. scrobiculatus*** (*C-27337*) (scale bar = 2 µm).

and bisporic. **Pleurocystidia** 38-48 x 5.2-5.6 µm, fusiform, scarce to absent. **Gill edge** with subcylindric to subclavate sterile elements, sinuous, 9.6-20.8 x 3.2-5.2 µm, sometimes capitate 24-28 x 7.2-10.4 µm. **Pseudocystidia** 3-6.5 µm wide, subcylindric, with refringent contents. **Pileipellis** an ixocutis; hyphae 1.6-4 µm wide, loosely arranged, forming a stratum 200-290 µm deep. **Context** hyphae 4-5.6 µm wide; laticifer hyphae 6.4-9.6 µm wide; sphaerocytes 6.4-32 µm wide. **Hymenophoral trama** hyphae 3.2-6.4 µm wide; laticifer hyphae 4-7 µm wide.

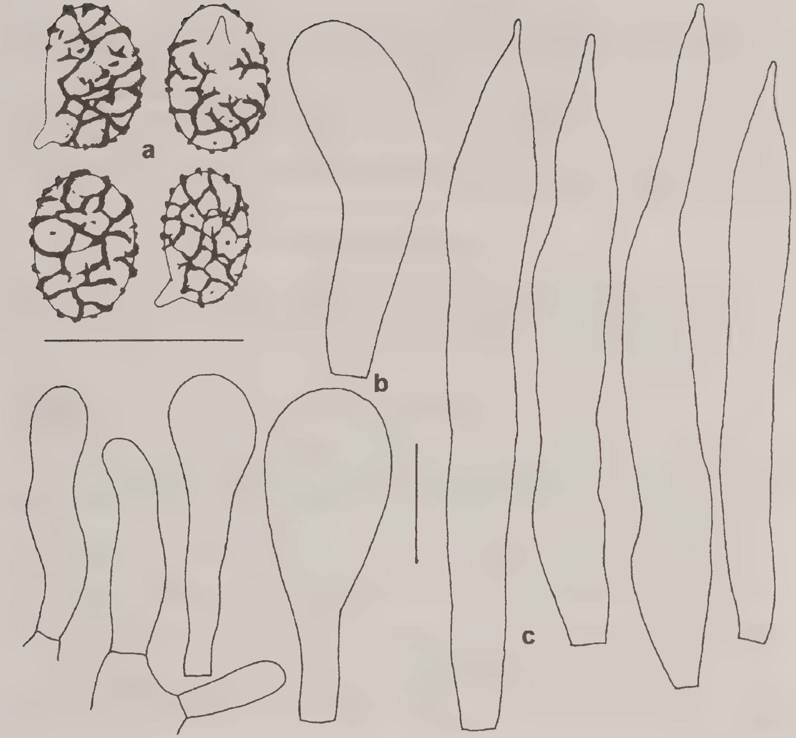

Fig.4. ***Lactarius smithii*** (*A.H. Smith 38436*). a: basidiospores. b: pleurocystidia. c: marginal cells of lamellae (scale bar = 10 µm).

Habitat — Solitary, under *Pinus* (Hesler and Smith 1960, 1979).

OTHER SPECIMENS EXAMINED — ***Lactarius scrobiculatus*** (var. ***scrobiculatus***). **SWEDEN**. **MEDELPAD**: Borgsjö par., Julasen, 22.VIII.1995, *Vesterholt & Elborne*, *JV95-305*, *C-27337* (C).

Comments — The following set of features, observed in *A.H. Smith 38436*, supports (as suggested by Kytovuori 1984) its segregation from *Lactarius scrobiculatus*: *a*) ellipsoid basidiospores [6.4-8 x 4.4-5.2 (-5.6) µm, 7 x 5 µm on avg., **Q** = 1.5]; *b*) these with ornamentation composed of a well defined reticulum (figs. 3 c-d, 4 a), and *c*) the glabrous pileus surface, finely fibrillose only towards the margin (Hesler and Smith 1960, 1979). *Lactarius scrobiculatus* presents *a*) basidiospores with a more constantly subglobose form [7.2-8.8 x 5.6-6.5 µm, 8 x 6 µm on avg., **Q** = 1.25, in the specimen *C-27337*; **Q** = 1.19-1.32, or **Q** = 1.23-1.38 according to Heilmann-Claussen et al. (1998) and Kytovuori (1984) respectively]; *b*) basidiospores irregularly cristulate (figs. 3 e-f) as observed in the specimen *C-27337* and based on the information by Kytovuori (1984) and Heilmann-Clausen et al. (1998), and *c*) the pileus surface finely squamulose

(Heilmann-Clausen et al. 1998). Another apparent difference between both taxa is the stipe surface, which is smooth and glabrous, only superficially spotted in the American taxon, as seen in the holotype (cf. Hesler and Smith 1960, 1979). The European taxon has a scrobiculate stipe, with unequal depressed spots on a pruinose background, and even a ring of coarse, rusty-brown hairs at the base of the scrobiculae (Kytovuori 1984). Based on all these distinctive features, we conclude that the specimen *A.H. Smith 38436* represents an independent species. As the epithet *pubescens* is preoccupied at specific rank, the new name *Lactarius smithii* is proposed.

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Literature Cited

Basso MT. 1999. *Lactarius* Pers. Fungi Europaei 7. Mykoflora, Alassio.

Beardslee HC, Burlingham G. 1940. Interesting species of Lactariae from Florida. Mycologia 32: 575-586.

Bessette AE, Bessette AR, Fischer DW. 1997. Mushrooms of Northeastern North America. Syracuse University, Syracuse.

Bills GF, Cotter VT. 1989. Taxonomy and Ethnomycology of *Lactarius* Sect. *Dapetes* (*Russulaceae*) in Nepal. Mem. N. Y. Bot. Gard. 49: 192-197.

Heilmann-Clausen J, Verbeken A, Vesterholt J. 1998. The genus *Lactarius*. Fungi of Northern Europe vol. 2, Denmark.

Hesler LR, Smith AH. 1960. Studies on *Lactarius*. II The North American species of sections *Scrobiculus*, *Crocei*, *Theiogali* and *Vellus*. Brittonia *12*: 306-350.

Hesler LR, Smith AH. 1979. North American Species of *Lactarius*. Univ. Michigan, Ann Arbor.

Holmgren PK, Holmgren NH, Barnett LC (eds.). 1990 – *Index Herbariorum*. Part I. The herbaria of the world, ed. 8. New York.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. 3th ed., Methuen, London.

Kytovuori I. 1984. *Lactarius* subsectio *Scrobiculati* in NW Europe. Karstenia 24: 41-72.

Lamoureux Y, Neumann P. 1991. Additions aux *Russulaceae* (Agaricales) du Québec. Naturaliste Can. 118: 3-14.

Montoya L, Bandala VM. 2003. Studies on *Lactarius*: a new combination and two new species from Mexico. Mycotaxon 85: 393-407.

Montoya L, Bandala VM., Herrera S, Ortiz J. 1998. An interesting record of *Lactarius* from the Gulf and Caribe. Zeit. Mykol. 64: 91-96.

Styles BT. 1993. Genus *Pinus*: a Mexican Purview, pp. 397-420. *In* Rammamorthy TP, Bye R, Lot A, Fa J (eds.). Biological Diversity of Mexico: Origins and Distribution. Oxford Univ, N. Y.

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Taxonomic studies on Ustilaginomycetes - 24

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Abstract — A new genus, *Ahmadiago,* and sixteen new species of smut fungi are described: *Entorrhiza citriformis, E. globoidea, Entyloma guizotiae, Microbotryum paucireticulatum, Sporisorium arundinellae-pumilae, S. blakeanum, S. euclastae, Tilletia acroceratis, T. imbecillis, T. kenyana, T. lyei, Tranzscheliella laevispora, Urocystis aurea, Ur. circaeasteri, Ustilago cynodonticola* and *U. duranii.* New names are: *Sporisorium arundinellae-nepalensis, S. leersiae-hexandrae, S. perforatum* and *S. shivasii.* The name *Tilletia oplismeni-cristati* is validated. New combinations proposed: *Ahmadiago euphorbiae, Jamesdicksonia eleocharidis, J. melinidis, Macalpinomyces neglectus, Sporisorium africanum, S. andropogonis-tectorum, S. arundinellae, S. furcatum, S. ischaemi, S. ischaemi-anthephoroides, S. ischaemicola, S. ischaemi-rugosi, S. mnesitheae, S. stuhlmanii, S. styppeiochloae, Thecaphora thlaspeos, Tilletia patagonica, Tranzscheliella amplexa, Tr. serena, Ustanciosporium eleocharidis.* Synonyms: *Tothiella* is considered to be *Thecaphora.* Nineteen species are placed in synonymy. Lectotype is designated for *Ustilago ugandensis* var. *macrospora.*

Key words — smut fungi, taxonomy

A new species of *Urocystis* on *Circaeaster* (Ranunculaceae)

Thirty-three known *Urocystis* species infect members of the Ranunculaceae. These occur on the genera: *Aconitum* (1), *Actaea* and *Cimicifuga* (1), *Adonis* (1), *Anemone* (5), *Aquilegia* (1), *Barneoudia* (1), *Callianthemum* (1), *Ceratocephalus* (1), *Clematis* (1), *Delphinium* (1), *Eranthis* (1), *Helleborus* (1), *Hepatica* (1), *Isopyrum* (1), *Pulsatilla* (2), *Ranunculus* (10), *Thalictrum* (1), *Trautvetteria* (1), and *Trollius* (1).

Recently, a *Urocystis* sp. was sent to me from the Harvard University Herbaria (FH), collected in China on *Circaeaster agrestis*, a tiny, annual plant. *Circaeaster* is a peculiar, unispecific genus in the Ranunculaceae, with primitive characters. Some authorities even recognise a separate family for it, Circaeasteraceae. Its parasite turned out to be a new species:

Urocystis circaeasteri Vánky, **sp. nov.**

Typus in matrice *Circaeaster agrestis* Maxim., China, Sichuan Province, Luhuo Xian, N. urbe Luhuo, via versus urbem Sêrtar, 31°39'36" N, 100°42'46" E, alt. cca. 3500 m.s.m., 1.IX.1997, leg. D.E. Boufford, M.J. Donoghue et R.H. Ree 27774A, comm. D.H. Pfister et E.W. Wood. Holotypus in HMAS, isotypi in FH et in Herbario Ustil. Vánky, HUV 20222!

Sori in pedunculi floralibus conspicue tumefactis, plerumque omnes eiusdem inflorescentiae inficientes, 1–1,5 x 2–2,5 mm, obovoidei vel ellipsoidales, in apice eorum cum residuis organorum floralium, primo membrana tenui, molybdea, e planta nutrienti orta obtecti, qua irregulariter rupta massam atrobrunneam, pulveream glomerulorum sporarum ostendentes. Rarius sori etiam in foliis sicut pustulae parvae, irregulares, elongatae vel ramificatae evoluti. *Glomeruli sporarum* globosi, subglobosi, ellipsoidales usque parum irregulares, 15–28 x 20–33 µm, flavido- usque pallide rufobrunnei, e sporis (0–)1–2(–3) compositi (0 = 0,5%, 1 = 88,5%, 2 = 9,5%, 3 = 1,5%), strato plerumque incompleto cellularum sterilium circumdati, cum exceptione sine cellulis sterilibus. *Sporae* globosae, ovoideae, ellipsoidales, raro latere uno deplanatae, 12–16 x 15–20(–21,5) µm, flavido- usque pallide rufo-brunneae; pariete aequali, 0,5–1 µm crasso, valde leniter, dense punctato-verruculoso. *Cellulae steriles* subglobosae, ovoideae, ellipsoidales, elongatae, saepe latere contacto parum deplanato, magnitudine variae, 4–8 x 5–12(–16) µm, pallide flavidobrunneae; pariete aequali vel inaequali, 0,5–1,5(–2,5) µm crasso, levi.

Sori (Fig. 1) in considerably swollen floral pedicels, usually infecting all in the inflorescence, obovoid or ellipsoidal, 1–1.5 x 2–2.5 mm, with remnants of floral organs on their tip, first covered by a thin, lead coloured membrane of host origin which ruptures irregularly, disclosing the dark brown, powdery mass of spore balls. Rarely, sori also on the leaves as small, irregular, elongated or ramifying pustules. *Spore balls* (Figs. 2, 3) globose, subglobose, ellipsoidal to slightly irregular, 15–28 x 20–33 µm, yellowish- to pale reddish-brown, composed of (0–)1–2(–3) spores (0 = 0.5%, 1 = 88.5%, 2 = 9.5%, 3 = 1.5%), surrounded by a usually incompletelayer of sterile cells, exceptionally sterile cells are lacking. *Spores* (Figs. 2, 3) globose, ovoid, ellipsoidal, rarely with a flattened side, 12–16 x 15–20(–21.5) µm, yellowish- to pale reddish-brown; wall even, 0.5–1 µm thick, very finely, densely punctate-verruculose. *Sterile cells* (Figs. 2, 3) subglobose, ovoid, ellipsoidal, elongated, often with a somewhat flattened contact side, variable in size, 4–8 x 5–12(–16) µm, pale yellowish-brown; wall even or uneven, 0.5–1.5 (–2.5) µm thick, smooth.

On Ranunculaceae (Circaeasteraceae): *Circaeaster agrestis* Maxim.; E. Asia (China). Known only from the type collection.

A new species of *Entyloma* on *Guizotia* (Asteraceae)

Guizotia Cass. is a genus of 10 species in tropical Africa. It belongs to the subfamily Asteroideae, tribe Heliantheae, subtribe Coreopsidinae. *Guizotia abyssinica* (L. fil.) Cass. (*G. oleifera* DC.) is cultivated in Africa and East India as an oil plant (Niger oil; Melchior, H. (ed.), Engler's Syllabus etc., 2:490, 1964). A smut fungus on the leaves of *G. abyssinica* has been collected in Ethiopia and preserved in IMI, under the collective name of *Entyloma compositarum* Farlow. On the genera of the subtribe Coreopsidinae

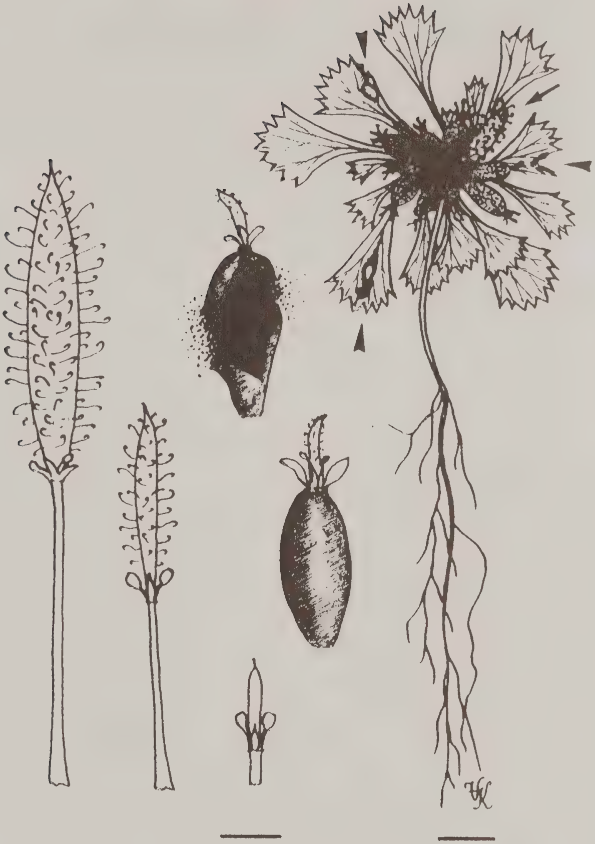

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Fig. 1. Sori of *Urocystis circaeasteri* in swollen floral pedicels and on some leaves (arrow heads) of *Circaeaster agrestis* (type). Habit (one fruit escaped infection, arrow), two sori (in the middle) and three healthy fruits of different ages (to the left).

Bars = 3 mm for habit, and 1 mm for detail drawings.

eight *Entyloma* species are known: *Bidens,* with 240 spp. has 4 *Entyloma* (comp. Vánky, 2003b:6), *Dahlia,* 15 spp./2 *Entyloma, Coreopsis,* 120/1, *Cosmos,* 29/1, *Guizotia,* 10/0, *Synderella* 2/0. The smut on *Guizotia* is described as:

Entyloma guizotiae Vánky, **sp. nov.**

Typus in matrice *Guizotia abyssinica* (L. fil.) Cass., Ethiopia, 1970, leg. M.K. Hingotani. Holotypus in IMI 153450, isotypus in HUV 17476!

Sori in foliis sicut maculae rotundae vel angulares, 0,5–3 mm diametro vel propter confluentiam earum majores, primo flavae, serius pallide vel atrius brunneae. *Sporae* globosae, subglobosae, ellipsoidales usque parum irregulares, nonnunquam latere uno deplanatae, 8–12 x 8–13 µm, subhyalinae; pariete aequali, 1(–1,5) µm crasso, levi; contentu granuloso. *Anamorpha* non visa.

Sori (Fig. 8) in the leaves as rounded or angular spots, 0.5–3 mm in diameter or larger by confluence, first yellow, later pale to dark brown. *Spores* (Figs. 4, 5) globose, subglobose, ellipsoidal to slightly irregular, sometimes with a flattened side, 8–12 x 8–13 µm, subhyaline; wall even, 1(–1.5) µm thick, smooth, content granular. *Anamorph* not seen.

On Asteraceae (subfamily Asteroideae): *Guizotia abyssinica* (L. fil.) Cass.; NE. Africa (Ethiopia). Known only from the type collection.

A new species of *Ustilago* on *Cynodon* (Poaceae)

Shivas & Vánky (2001) revised the smut fungi of *Cynodon,* and recognised six species: **1.** ***Sporisorium cynodontis*** (L. Ling) R.G. Shivas & Vánky, **2.** ***S. normanense*** R.G. Shivas & Vánky, **3.** ***Tilletia cynodontis*** Vánky, **4.** ***Ustilago cynodontis*** (Henn.) Henn., **5.** ***U. hitchcockiana*** Zundel, and **6.** ***U. paraguariensis*** Speg. Recently, a different species was discovered in South Africa:

Ustilago cynodonticola Vánky, R.G. Shivas & A. Witt, **sp. nov.**

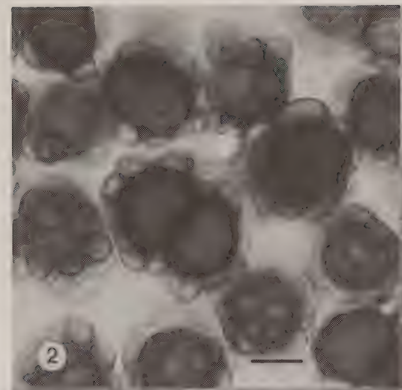
Typus in matrice *Cynodon dactylon* (L.) Pers., South Africa, KwaZulu-Natal Prov., cca. 30 km N.E. oppid. Newcastle, 27°35'25" S, 30°02'37" E, alt. cca. 1270 m.s.m., 23.XII.2002, leg. R.G. Shivas, A. Witt & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 20150; isotypi in PREM 57600, BRIP 39698 et in Vánky, Ust. exs. no. 1190. Paratypi: *Cynodon bradleyi* Stent, S. Africa, Transvaal, Ermelo, 26°32' S, 29°59' E, 2.III.1927, leg. M. Henrici, PREM 21111, HUV 20269; *Cynodon dactylon,* S. Africa, Cape Prov., Somerset-East, 1877, leg. P. MacOwan, HUV 3577, isoparatypi in Thümen, Mycoth. univ. no. 1418 (sicut *Ustilago carbo*); North-Western Prov., Pretoria, Botanical Garden, 25°44'17" S, 28°16'33" E, alt. cca. 1375 m.s.m., 7.XII.2002, leg. R.G. Shivas & K. Vánky, BRIP 39697, HUV 20151, PREM 57601; *Cynodon incompletus* Nees, S. Africa, Eastern Cape Prov., cca. 30 km S. oppid. Alice, Doubledrift Nature Reserve, 32°59'32" S, 25°50'18" E, alt. cca. 540 m.s.m., 15.XII.2002, leg. R.G. Shivas, A. Witt & K. Vánky, BRIP 39700, HUV 20153, PREM 57602.

Figs. 2, 3. Spore balls, spores and sterile cells of *Urocystis circaeasteri* on *Circaeaster agrestis,* in LM and in SEM (type).

Figs. 4, 5. Spores of *Entyloma guizotiae* on *Guizotia abyssinica,* in LM and in SEM (type).

Figs. 6, 7. Spores of *Ustilago cynodonticola* on *Cynodon dactylon,* in LM and in SEM (type).

Bars = 10 µm.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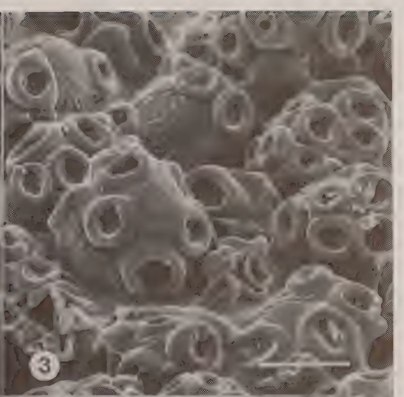
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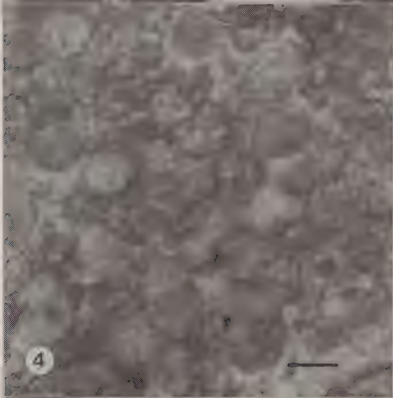
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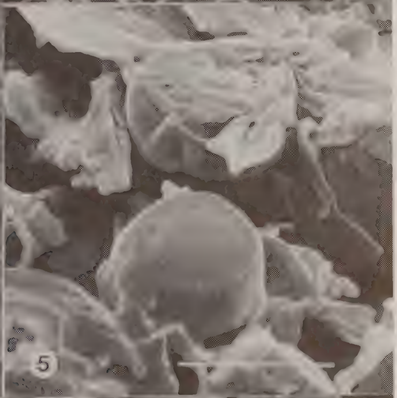
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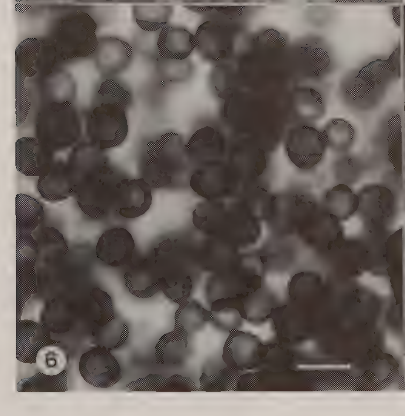
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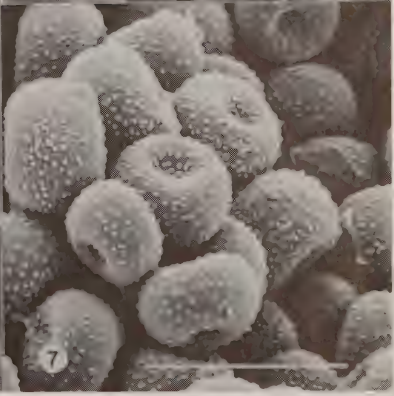
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Sori in apice surculorum sterilium, folia suprema congesta, praecipue partem basalem eorum requirentes, saepe apicem foliorum intactum relinquentes, tumefacti, distaliter attenuati, 1,5–4 x 10–35 mm, primo virides, serius atrocinerei, epidermide inter nervos in nonnullos particulos discesso obtecti, massam sporarum nigrobrunneam, semiagglutinatam usque pulveream ostendentes. *Sporae* globosae, subglobosae, ovoideae vel ellipsoidales, 6–8,5 x 6,5–9,5 µm, flavidobrunneae; pariete aequali, 0,5–0,7 µm crasso, leniter, moderate dense punctato-verruculoso; imago obliqua sporarum levis.

Sori (Fig. 9) on the top of sterile shoots, comprising the uppermost, congested leaves, especially their basal parts, swollen, narrowing distally, often with intact tips of the leaves, 1.5–4 x 10–35 mm, first green, later dark grey, covered by the epidermis which ruptures in several places between the veins, disclosing the blackish-brown, semi-agglutinated to powdery mass of spores. *Spores* (Figs. 6, 7) globose, subglobose, ovoid or ellipsoidal, 6–8.5 x 6.5–9.5 µm, yellowish-brown; wall even, 0.5–0.7 µm thick, finely, moderately densely punctate-verruculose, spore profile smooth.

On *Cynodon dactylon* (L.) Pers., *C. bradleyi* Stent, and *C. incompletus* Nees; S. Africa. Not rare.

Ustilago cynodonticola differs from the common *U. cynodontis*, in which the sori destroy the inflorescence, and the spores are slightly smaller (5.5–8 x 6–8(–8.5) µm) and smooth, as seen in LM. *U. cynodonticola* differs also from the South American *U. paraguariensis*, in which the sori are in the distal, shortened internodes of the stem, the spores are somewhat larger (7–9.5 x 7–11 µm) and sparsely verrucose.

The smut fungi on *Oplismenus* (Poaceae)

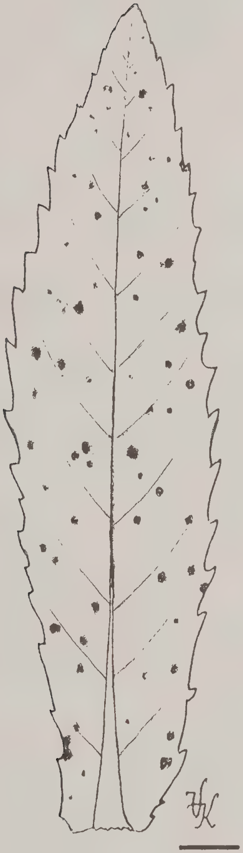
Oplismenus P. Beauv., with five very closely related species, in the tropics and subtropics, belongs to the subfamily Panicoideae, tribe Paniceae, subtribe Setariinae (Clayton & Renvoize, 1986:271). The following four smut fungi are known on *Oplismenus*, including a new species.

1. *Tilletia imbecillis* Vánky, sp. nov.

Typus in matrice *Oplismenus imbecillis* (R. Br.) Roem. & Schult., Australia, Queensland, McPherson Range, National Park, 5.VI.1947, leg. R.F. Langdon (sub *T. vittata*). Holotypus in BRIP 7831, isotypus in HUV 18649!

Sori in ovariis sparsis, hypertrophicis, elongate cylindrici, saepe parum inclinati, 1–1,5 x 10–25 mm, membrana hispida, origine matricali, venis parallelis, cooperti, in maturitate, membrana obtegenti longitudinaliter rupta massam atrobrunneam, pulveream sporarum, cellulis sterilibus intermixtam ostendentes. *Sporae* subglobosae, ovoideae, ellipsoidales usque elongatae, raro irregulares, 16–21 x 16–23 µm, elongatae earum usque 26–30 µm longae, flavae usque flavidobrunneae; pariete aequali, 1,5–2 µm crasso, verrucis 1–1,5 µm altis, in superficie sporae irregulariter sparsis, non in greges coacervatis inclusis. Apices verrucarum in visu opticali mediano deplanati. *Cellulae steriles* subglobosae, ellipsoidales usque parum irregulares, saepe collapsae, 13–23 x 14–25 µm, pallide flavae; pariete 0,5–1,5 µm crasso, levi usque aspero.

Sori (Fig. 16) in scattered, hypertrophied ovaries, long cylindrical, often slightly bent, 1–1.5 x 10–25 mm, covered by a hispid membrane of host origin with parallel veins. At maturity the covering membrane ruptures



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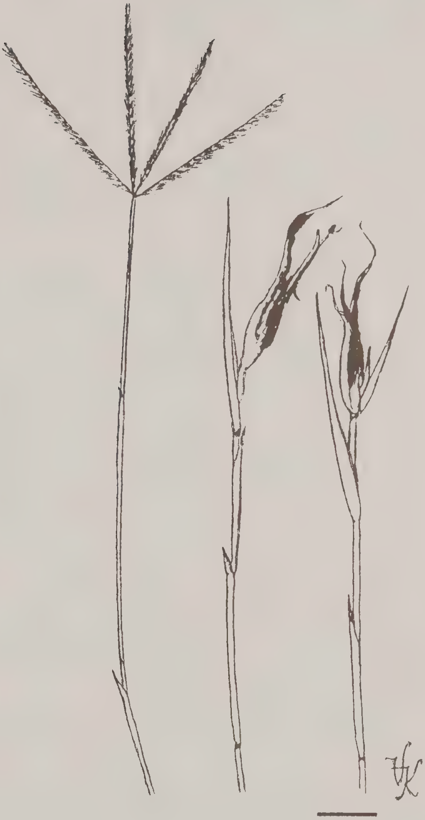

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Fig. 8. Sori of *Entyloma guizotiae* as small spots on a leaf of *Guizotia abyssinica* (type).
Fig. 9. Sori of *Ustilago cynodonticola* on *Cynodon dactylon* (type). Two infected shoots and a healthy inflorescence. Bars = 1 cm.

longitudinally disclosing the dark brown, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 10, 11) subglobose, ovoid, ellipsoidal to elongated, rarely irregular, 16–21 x 16–23 µm, elongate spores up to 26–30 µm long, yellow to yellowish-brown; wall even, 1.5–2 µm thick, including the 1–1.5 µm high warts which are irregularly scattered on the spore surface without grouping into clusters. In optical median view the tips of the warts are flattened. *Sterile cells* subglobose, ellipsoidal to slightly irregular, often collapsed, 13–23 x 14–25 µm, pale yellow; wall 0.5–1.5 µm thick, smooth to rough.

On *Oplismenus imbecillis* (R. Br.) Roem. & Schult. (*O. hirtellus* (L.) P. Beauv. subsp. *imbecillis* (R. Br.) U. Scholz; *O. undulatifolius* (Ard.) Roem. & Schult. var. *imbecillis* (R. Br.) Hackel); Australia. Known only from the type collection.

The larger, often ellipsoidal spores and the spore surface ornamentation differentiate this species from the other two *Tilletia* species on *Oplismenus*.

2. ***Tilletia oplismeni-cristati*** Patouillard & Hariot ex Vánky

"*Tilletia oplismeni-cristati* Pat. and Har., sp. nov." in Durán & Fischer, 1961:87. Invalidly published, no type indicated (ICBN 37.1). — Typus in matrice *Oplismenus burmannii* (Retz.) P. Beauv., Mexico, cca. 1 km E. Hotel Villa Blanca, Capilla de Taxte, off Hwy 40, 24.X.1976, leg. R. Durán & P.M. Gray. Holotypus in HUV 14046!, isotypus in WSP 68372. Paratypus: ibidem, 10.X.1978, R. Durán et P.M. Gray, HUV 14047!, isoparatypus in WSP 68614.

Sori in ovariis sparsis, late fusiformes, 0,7–1,5 x 2–5 mm, membrana hispida, origine matricali cooperti, qua longitudinaliter rupta massam nigrobrunneam, pulveream, cellulis sterilibus intermixtam ostendentes. *Sporae* globosae usque subglobosae, 17,5–21,5 x 18–21,5 µm, flavido- usque nigrobrunneae; pariete gregibus verrucarum 1,5–2,5 µm altarum, in visu opticali mediano apicibus deplanatis instructo. Greges e 10–30 verrucis formati aspectum pigmentationis inaequalis superficiei sporarum efficientes. *Cellulae steriles* globosae, ovoideae usque parum irregulares, magnitudine variae, 7–19 x 8–21 µm, subhyalinae usque fumose tincto flavae; pariete 1–1,5 µm crasso, levi. *Germinatio sporarum* basidiis aseptatis, apicaliter basidiosporas aciculares, multas, polyspermales, non conjugantes producentibus (Durán et Fischer, 1961, p. 161, tab. 86, D, F).

Sori in scattered ovaries, broadly fusiform, 0.7–1.5 x 2–5 mm, covered by a hispid membrane of host origin which ruptures longitudinally disclosing the blackish-brown, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 12, 13) globose to subglobose, 17.5–21.5 x 18–21.5 µm, yellowish- to dark brown; wall provided with clusters of verrucae, 1.5–2.5 µm high, in optical median view with flattened tips. The clusters, formed of 10–30 verrucae, give the spore surface the appearance of being unevenly pigmented. *Sterile cells* (Figs. 12, 13) globose, ovoid to slightly irregular, variable in size, 7–19 x 8–21 µm, subhyaline to smoky tinted yellow; wall 1–1.5 µm thick, smooth. *Spore germination* results in aseptate basidia producing apically numerous, acicular, multinucleate basidiospores which do not fuse (Durán & Fischer, 1961:161, Pl. 86, D, F).

On *Oplismenus burmannii* (Retz.) P. Beauv. (*O. humboldtianus* Nees), *Oplismenus* sp.; C. Africa (Malawi), N. America (Mexico), C. America (Costa Rica, Guatemala), West Indies (Guadeloupe).

The spores of *Tilletia oplismeni-cristati* on *Oplismenus* sp. from Malawi (IMI 50425) are somewhat smaller (15.5–19 x 16.5–20 µm) than those of the type, but the spore ornamentation, i.e. warts arranged in clusters, typical for this species, is present.

3. ***Tilletia vittata*** (Berk.) Mundkur, 1940:312.

Ustilago vittata Berkeley, 1853:148. — *Neovossia vittata* (Berk.) Shetty & Safeeulla, 1980(1981):399. — Type on "Oplismenoid grass" (= *Oplismenus compositus* (L.) P. Beauv., teste C.E. Hubbard), India, Bihar, Parasnath, alt. 4000 ft, before 1854, coll. Hooker, K.

Tilletia panici Mundkur, 1940:317. — Type on *Panicum* sp., India, W. Bengal, Calcutta, I.1928, K. Bagchee, HCIO 7807; isotypes IMI, HUV 16375! (syn. by Ling, 1949a:123, confirmed).

Tilletia vittata (Berk.) Mundkur var. *burmannii* Mishra, 1957:260. — Type on *Oplismenus burmannii* (Retz.) P. Beauv., India, Bihar, Netarhat, alt. 3500 ft, J.N. Mishra, HCIO?; isotypes IMI 68168, HUV 17470! (syn. by Durán & Fischer, 1961:117, confirmed).

Sori in scattered, hypertrophied ovaries, cylindrical, usually slightly bent, 1–2 x 3–15(–20) mm, covered by a hispid membrane of host origin with parallel veins. At maturity the membrane ruptures longitudinally, sometimes in several places, disclosing the black, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 14, 15) globose to subglobose, 14–19 x 15–20 µm, yellowish- or dark reddish-brown to subopaque; wall 1.5–2 µm thick provided with rather densely, somewhat irregularly situated, 1–1.5 µm high warts which may form short, irregular chains but not agglomerated in clusters, in optical median view with subacute, acute or flattened tips. *Sterile cells* (Figs. 14, 15) subglobose, ovoid to slightly irregular, variable in size, 9–17 x 9–19 µm, pale olivaceous-brown; wall 1–2.5 µm thick, smooth, indistinctly or finely verruculose.

On *Oplismenus burmannii* (Retz.) P. Beauv., *O. compositus* (L.) P. Beauv., *O. hirtellus* (L.) P. Beauv., *O. setarius* (Lam.) Roem. & Schult., *O. undulatifolius* (Ard.) P. Beauv., *Panicum* sp.; Africa (Guinea, Uganda), Asia (India), N. America (Mexico).

4. ***Ustilago oplismeni*** Viennot-Bourgin, 1959:9.

Type on *Oplismenus humboldtianus* Nees (= *O. burmannii* (Retz.) Beauv.), Guinea (French), near Roka, I.1957, G. Viennot-Bourgin.

Sori in the spikelets, hidden by the glumes, blackish-brown, powdery. *Spores* globose, 3–5.5 x 3–5.5 µm, olivaceous-brown; wall thin, irregularly ornamented with 1–1.5 µm high, irregular tubercles.

On *Oplismenus burmannii* (Retz.) Beauv. (*O. humboldtinanus* Nees); Africa (Guinea). Known only from the type locality.

Unfortunately, the type specimen seems to be lost. It is neither in the Herb. Viennot-Bourgin in PC, nor in the general mycological herbarium of PC (Dr. J. Mouchacca, pers. comm.). The rather poor description is taken from the original. I suspect that this fungus is an *Ustilaginoidea* (anamorphic Ascomycetes).

Key to the smut fungi (*Tilletia*) on *Oplismenus*

1. Sori in the spikelets, spores 3–5.5 µm long................[***Ustilago oplismeni***]
– Sori in hypertrophied ovaries, spores larger..2
2. Spores subglobose to long ellipsoidal, 16–23(–30) µm long .***T. imbecillis***
– Spores globose to subglobose, smaller..3
3. Spores 18–21.5 µm long, yellowish- to dark brown;
warts 1.5–2.5 µm long, arranged in clusters................***T. oplismeni-cristati***
– Spores 15–20 µm long, dark brown to subopaque;
warts 1–1.5 µm long, not arranged in clusters ....***T. vittata***

A new species of *Tilletia* on *Brachypodium* (Poaceae)

Five *Tilletia* species are known on *Brachypodium:* **1. *T. brachypodii*** Mundkur, type on *B. sylvaticum,* India, **2. *T. brachypodii-mexicani*** Vánky, type on *B. mexicanum,* Venezuela, **3. *T. brachypodii-ramosi*** Zogg, type on *B. ramosum,* France, **4. *T. colombiana*** Vánky, type on *B. mexicanum,* Colombia, and **5. *T. olida*** (Riess) J. Schröt., type on *B. pinnatum,* Germany. Of these, 1, 2 and 4 have sori in the ovaries, 3 and 5 in the leaves. A different, ovaricolous smut was discovered in the phanerogam collection of MHU, Kampala, Uganda, and also obtained from Prof. K.A. Lye.

Tilletia lyei Vánky, sp. nov.

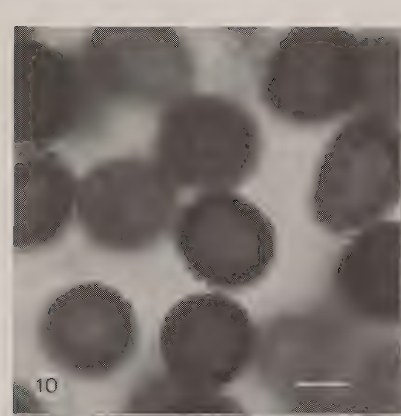
Typus in matrice *Brachypodium flexum* Nees, Kenya, Kitale Distr., Mt. Elgon, "2–3 km below the parking place on the northern Mt. Elgon Road, in edge of road in forest", 01°22' N, 22°39' E, alt. cca. 3000 m.s.m., 19.I.1969, leg. K.A. Lye 1508. Holotypus in HUV 19980!, isotypi in Herb. K.A. Lye et in MHU.

Sori in ovariis nonnullis, tumefactis inflorescentiae eiusdem, cylindrici, apice acuto, 0,5–1,5 x 4–7 mm, pericarpio brunneo cooperti, quo maturitate longitudinaliter rupto massam nigram pulveream sporarum cellulis sterilibus mixtam ostendentes. *Sporae* globosae, subglobosae, ellipsoidales, 14,5–18,5 x 16–20 µm, fumose tincto flavidobrunneae; pariete aequali, 1–1,5 µm crasso, dense verrucoso; verrucae in visu opticali mediano 0,5–1 µm altae, obtusae; imago obliqua sporarum undulata. *Cellulae steriles* subglobosae, ellipsoidales, irregulares, saepe collapsae, 17–30 µm longae, subhyalinae; pariete 3–4 µm crasso, levi usque punctato-verrucoso.

Figs. 10, 11. Spores of *Tilletia imbecillis* on *Oplismenus imbecillis*, in LM and in SEM (type).

Figs. 12, 13. Spores and sterile cells of *Tilletia oplismeni-cristati* on *Oplismenus burmannii*, in LM and in SEM (type).

Figs. 14, 15. Spores and sterile cells of *Tilletia vittata* on *Oplismenus compositus*, in LM and in SEM (India, Uttar Pradesh, Garwal Himalaya Mts., 33 km N. of Rudraprayag, 15.IX.1992, T. & K. Vánky, HUV 15692). Bars = 10 µm.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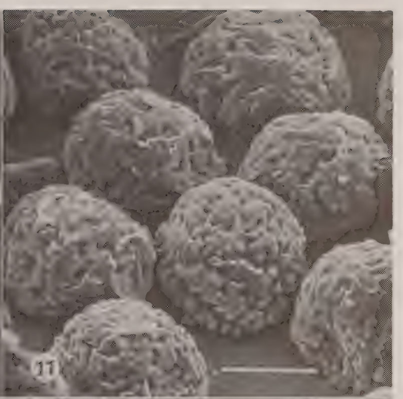
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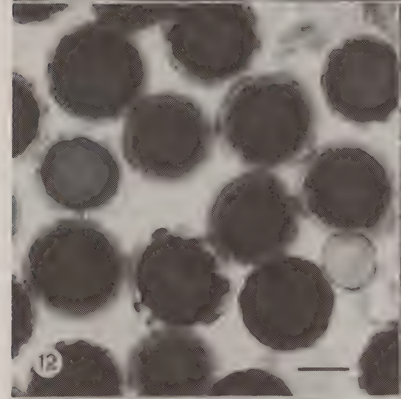
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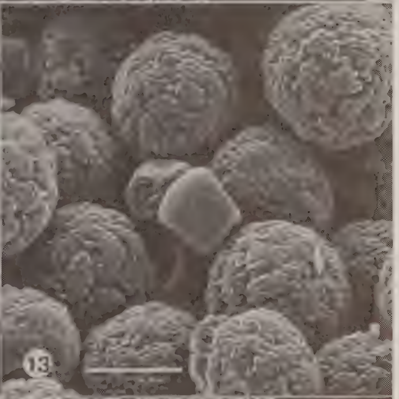
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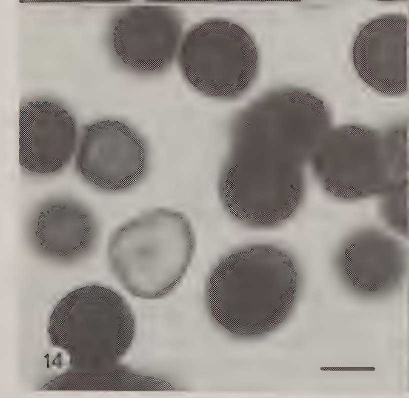
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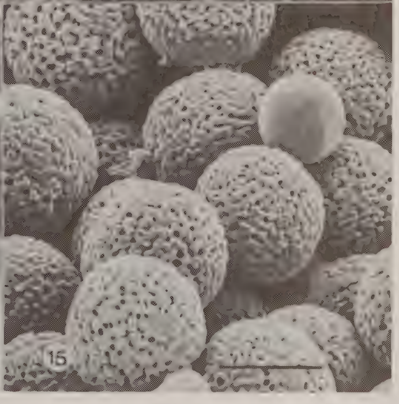
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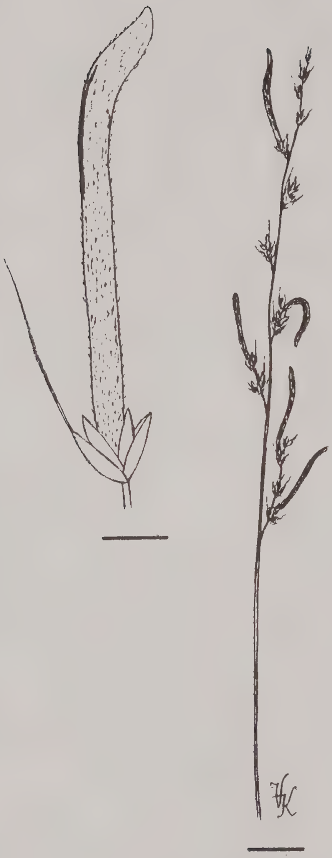

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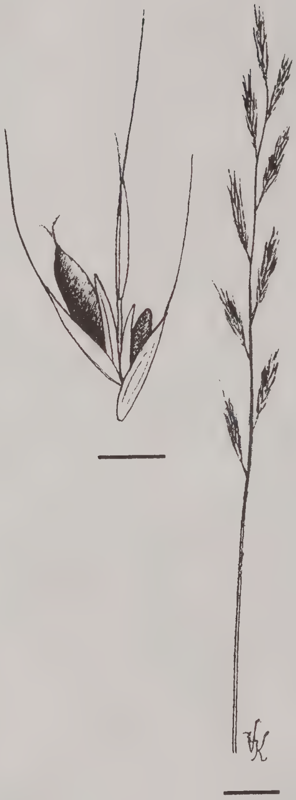

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Fig. 16. Sori of *Tilletia imbecillis* in hypertrophied ovaries of *Oplismenus imbecillis* (type). Habit, and enlarged a sorus.

Fig. 17. Sori of *Tilletia lyei* in swollen ovaries of *Brachypodium flexum* (type). Habit, and enlarged two sori. Bars = 1 cm for habit, and 3 mm for detail drawings.

Sori (Fig. 17) in some swollen ovaries of an inflorescence, cylindrical with acute tip, 0.5–1.5 x 4–7 mm, covered by the brown pericarp which ruptures longitudinally at maturity disclosing the black, powdery mass of spores mixed with sterile cells. *Spores* (Figs. 20, 21) globose, subglobose, ellipsoidal, 14.5–18.5 x 16–20 µm, smoky tinted yellowish-brown; wall even, 1–1.5 µm thick, densely verruculose; warts in optical median view 0.5–1 µm high, blunt, spore profile wavy. *Sterile cells* (Figs. 20, 21) subglobose, ellipsoidal, irregular, often collapsed, 17–30 µm long, subhyaline; wall 3–4 µm thick, smooth to punctate-verruculose.

On *Brachypodium flexum* Nees; Africa (Kenya). Known only from the type locality.

Tilletia lyei differs from other *Tilletia* species of *Brachypodium* especially by the low, blunt ornamentation of the spores.

Etymology: This species is named in honour of Prof. Kåre Arnstein Lye (Ås-NLH, Norway), an exceptional, helpful person and friend, world-authority on Cyperaceae, outstanding specialist of the flora of Scandinavia and Tropical Africa in general, and that of Uganda in particular, who also collected this smut fungus.

Key to the *Tilletia* species of *Brachypodium*

1. Sori in leaves as long striae. Spores reticulate 2
– Sori in swollen ovaries. Spores otherwise ornamented 3
2. Muri 0.5–1(–1.5) µm high, truncate .... ***T. olida***
– Muri 1–1.5(–2.5) µm high, pointed .... ***T. brachypodii-ramosi***
3. Spores coarsely tuberculate, surrounded by a thick sheath .. ***T. brachypodii***
– Spores verrucose, sheath apparently lacking... 4
4. Spores chocolate-brown to opaque, 17.5–24(–26) µm long,
warts 1–2.5 µm long.. ***T. brachypodii-mexicani***
– Spores paler, smaller, up to 20 µm long, warts shorter 5
5. Warts 1–1.5(–2) µm high, pointed .... ***T. colombiana***
– Warts 0.5–1 µm high, blunt... ***T. lyei***

Two new species of *Entorrhiza*

Ten species of *Entorrhiza* are known, all forming galls on the roots of Cyperaceae (*Carex, Cyperus, Eleocharis, Scirpus,* including *Isolepis*) and Juncaceae (*Juncus*). Of the ten species, four have spores ornamented by ridges. Two additional species of this group are:

Entorrhiza citriformis Vánky & McKenzie, **sp. nov.**

Typus in matrice *Scirpus reticularis* (Col.) Edgar (*Isolepis reticularis* Col.; det. K.A. Ford, CHR), New Zealand, South Island, 23 km N.W. oppid. Wanaka, Diamond Lake, 44°38'54" S, 168°57'45" E, alt. cca. 330 m.s.m., 5.II.1998, leg. E.H.C. McKenzie, C. & K. Vánky. Holotypus in PDD 70949, isotypus in Herbario Ustil. Vánky, HUV 19051!

Entorrhiza citriformis ab *E. fineraniae* Vánky (Mycotaxon 43:419, 1992; typus in matrice *Scirpus cernuus* Vahl, New Zealand), imprimis sporis citriformibus, latioribus distincta, magnitudine 17–23 x 23–29 µm, cristis pluribus (22–30 in circumscriptione aequatoriali sporae) instructis. Magnitudo sporarum *E. fineraniae* 12–16 x 15–25(–30) µm, conspectu secundum axem longitudinalem sporae cristis 14–20(–24) in circumscriptione aequatoriali sporae apparentibus.

Sori (Fig. 18) on the roots as light to dark brown, guttiform, fusiform, cylindrical, elongated, often slightly bent, not branching galls, 1–2.5 x 2–15 mm, filled by pale brown, agglutinated, intracellular spore masses. *Spores* (Figs. 22, 23) lemon-shaped, with a papilla on one end, and a short appendage on the opposite side (the remnant of the sporogenous hypha), 17–23 x 23–29 µm (including ornamentation), pale to dark lemon-yellow; wall more or less even, 4–5 µm thick, surface provided with coarse ridges situated parallel to the long axis of the spore, in lateral view 9–12 ridges are visible; looking from the longitudinal axis of the spore, 22–30 ridges appear on the equatorial circumference of a spore.

On Cyperaceae: *Scirpus reticularis* (Col.) Edgar (*Isolepis reticularis* Col.); New Zealand. Known only from the type collection.

Entorrhiza citriformis differs from *E. fineraniae* Vánky, especially by the lemon-shaped, much wider spores, provided with more ridges. In *E. fineraniae* the spores are 12–16 µm wide, ornamented with 14–20(–24) ridges.

Entorrhiza globoidea Vánky, **sp. nov.**

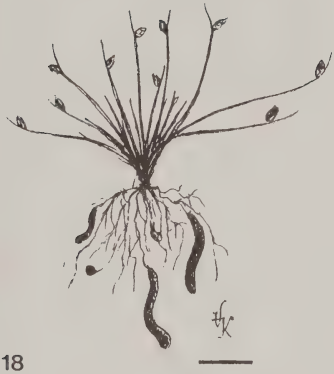
Typus in matrice *Scirpus fluitans* L., Australia, Western Australia, cca. 12 km W. oppid. Moora, 30°36'37" S, 115°51'29" E, alt. cca. 310 m.s.m., 11.IX.1999, leg. C. & K. Vánky. Holotypus in BRIP 39623, isotypus in Herbario Ustil. Vánky, HUV 19052!

Entorrhiza globoidea ab *E. fineraniae* Vánky (Mycotaxon 43:419, 1992; typus in matrice *Scirpus cernuus* Vahl, New Zealand) imprimis sporis globoideis, valde latioribus, 17–21.5(–24) x 17–24(–25) µm, cristis pluribus (20–27) in circumscriptione aequatoriali sporae instructis distincta. Sporae *E. fineraniae* 12–16 x 15–25(–30) µm, conspectu secundum axem longitudinalem sporae cristis 14–20(–24) in circumscriptione aequatoriali sporae apparentibus.

Sori (Fig. 19) on the roots as light to dark brown, globoid, ovoid, pyriform or elongated galls, when dried 1–3 x 1–6 mm, filled by pale brown, agglutinated, intracellular spore masses. *Spores* (Figs. 24, 25) globose or subglobose, rarely broadly ellipsoidal, with a papilla on one end, and a short appendage on the opposite side, 17–21.5(–24) x 17–24(–25) µm, pale yellow to lemon-yellow; wall even, 2.5–4 µm thick, surface provided with coarse ridges situated parallel to the pedicel-papilla axis of the spore, in lateral view 7–12 ridges are visible; looking from the "longitudinal" axis of the spore, 20–27 ridges appear on the equatorial circumference of a spore.

On Cyperaceae: *Scirpus fluitans* L. (*Isolepis fluitans* (L.) R. Br.), Australia. Known only from the type collection.

Entorrhiza globoidea differs from *E. fineraniae* Vánky, especially by the globoid, much wider spores, provided with more ridges. In *E. fineraniae* the spores are 12–16 µm wide, ornamented with 14–20(–24) ridges. *Entorrhiza globoidea* differs from *E. citriformis* especially by the globoid, shorter spores.



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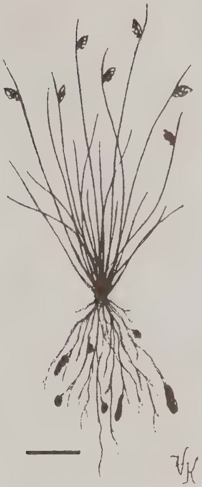

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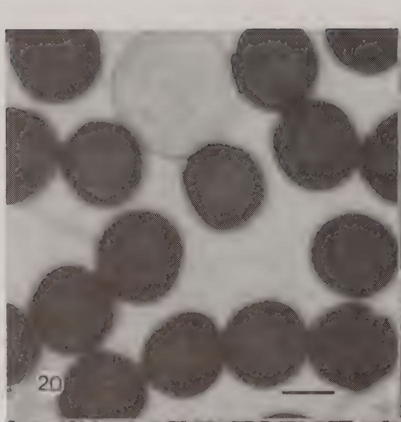
Fig. 18. Sori of *Entorrhiza citriformis* on the roots of *Scirpus reticularis*, forming galls (type).
Fig. 19. Sori of *Entorrhiza globoidea* on the roots of *Scirpus fluitans*, forming galls (type).
Bars = 1 cm.

Key to the *Entorrhiza* species with ridged spore wall

1. Ridges parallel to the long axis of the spores..2
– Ridges obliquely oriented 5
2. Spores 9–12 x 12–20 µm, with 12–16 ridges; wall c. 1 µm thick.***E. parvula***
– Spores larger, with more ridges; wall thicker...3
3. Spores 12–16 µm wide, with 14–20(–24) ridges ....***E. fineraniae***
– Spores 17–23(–25) µm wide, with more ridges 4
4. Spores globoid, 17–24(–25) µm long, with 20–27 ridges.........***E. globoidea***
– Spores lemon-shaped, 23–29 µm long, with 22–30 ridges ....***E. citriformis***
5. Spores subglobose to ellipsoidal, 11–16 µm wide, with
7–11 ridges...***E. scirpicola***
– Spores elongate-ellipsoidal or lemon-shaped, 9–12 µm wide,
with 10–14 ridges...***E. raunkiaeriana***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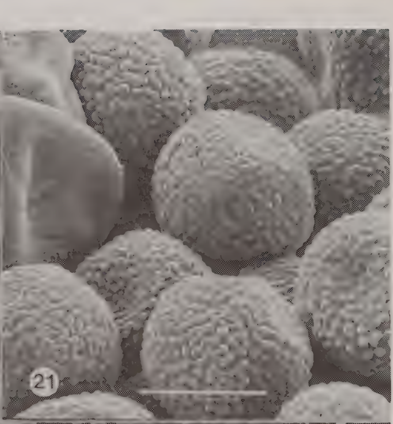
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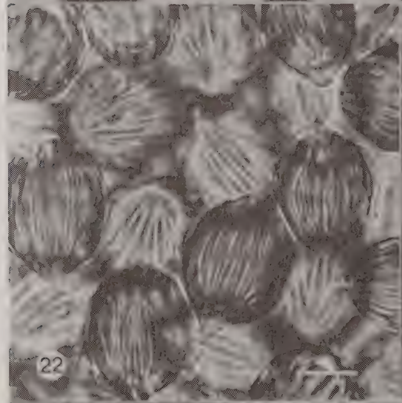
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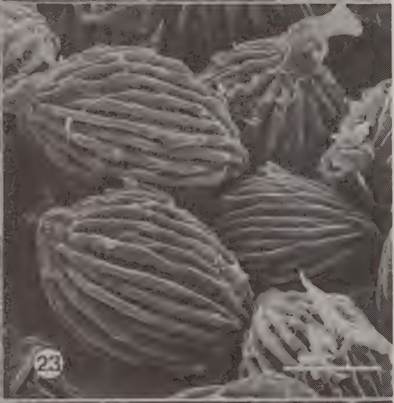
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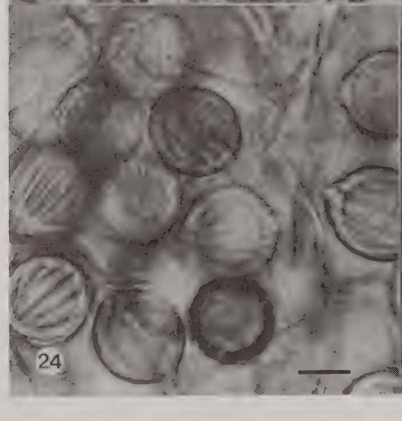
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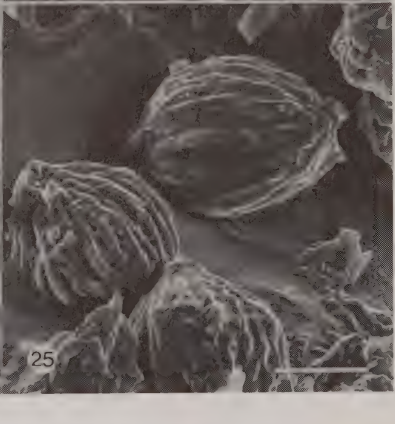
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A second smut fungus on *Acroceras* (Poaceae)

The first smut fungus described on *Acroceras* Stapf, a genus of 19 species, was *Ustilago acroceratis* Vánky, recorded on *Acroceras macrum* from Zimbabwe, Harare (Vánky, 2001:293). A *Tilletia* species, collected on the same host, at the same place, is a new species:

Tilletia acroceratis Vánky, sp. nov.

Typus in matrice *Acroceras macrum* Stapf, Zimbabwe, Harare, 27.III.1941, leg. A. Rattray (as aff. *Tilletia heterospora*). Holotypus in PREM 33750 (ex "Myc. Herb. S. Rhodesia 5282"), isotypus in Herbario Ustil. Vánky, HUV 20270!

Sori in nonnullis ovariis inflorescentiae eiusdem, inter involucris floralibus patentibus apparentes, ovoidei, 3–5 mm longi, primum membrana brunnea pericarpii cooperti, qua irregulariter rupta massa atrobrunnea, pulverea sporarum cellularumque sterilium dispersa. *Sporae* globosae, subglobosae, raro ovoideae vel late ellipsoidales, magnitudine variae, 17–22,5 x 17–25 µm, flavidobrunneae usque atro-chocolatobrunneae, verrucis dense distributis, verrucis dense distributis, 1,5–2,5 µm altis, polyangularibus, apice deplanatis, in visu superficiali sicut areae polyangulares, atriores apparentibus, per diametrum sporae 7–10. *Cellulae steriles* globosae, subglobosae, ovoideae usque parum irregulares, magnitudine nimis variae (globosae vel subglobosae earum 9–50 µm), hyalinae usque parum flavidobrunneae; pariete 1–4(–8) µm crasso, levi, verrucoso vel atypice ornato. Forma intermediae fere omnes a cellulis hyalinis, levibus usque ad sporas atras, typice ornatas evolutae.

Sori in some ovaries of an inflorescence, appearing between the spreading floral envelopes, ovoid, 3–5 mm long, first covered by a brown membrane of the pericarp which ruptures irregularly and the dark brown, powdery mass of spores and sterile cells are dispersed. *Spores* (Figs. 27, 28) globose, subglobose, rarely ovoid or broadly ellipsoidal, variable in size, 17–22.5 x 17–25 µm, yellowish-brown to dark chocolate-brown, provided with densely situated, 1.5–2.5 µm high, polyangular warts with flattened top, in surface view appearing as darker, polyangular areas, 7–10 per spore diameter. *Sterile cells* (Figs. 27, 28) globose, subglobose, ovoid to slightly irregular, extremely variable in size (globose or subglobose cells 9–50 µm in diameter), hyaline to pale yellowish-brown; wall 1–4(–8) µm thick, smooth, verrucose or with atypical ornamentation. There are almost all intermediate forms from hyaline, smooth cells to dark, typically ornamented spores.

On *Acroceras macrum* Stapf; Africa (Zimbabwe). Known only from the type collection.

Figs. 20, 21. Spores and sterile cells of *Tilletia lyei* on *Brachypodium flexum*, in LM and in SEM (type).

Figs. 22, 23. Spores of *Entorrhiza citriformis* on *Scirpus reticularis*, in LM and in SEM (type).

Figs. 24, 25. Spores of *Entorrhiza globoidea* on *Scirpus fluitans*, in LM and in SEM (type).

Bars = 10 µm.

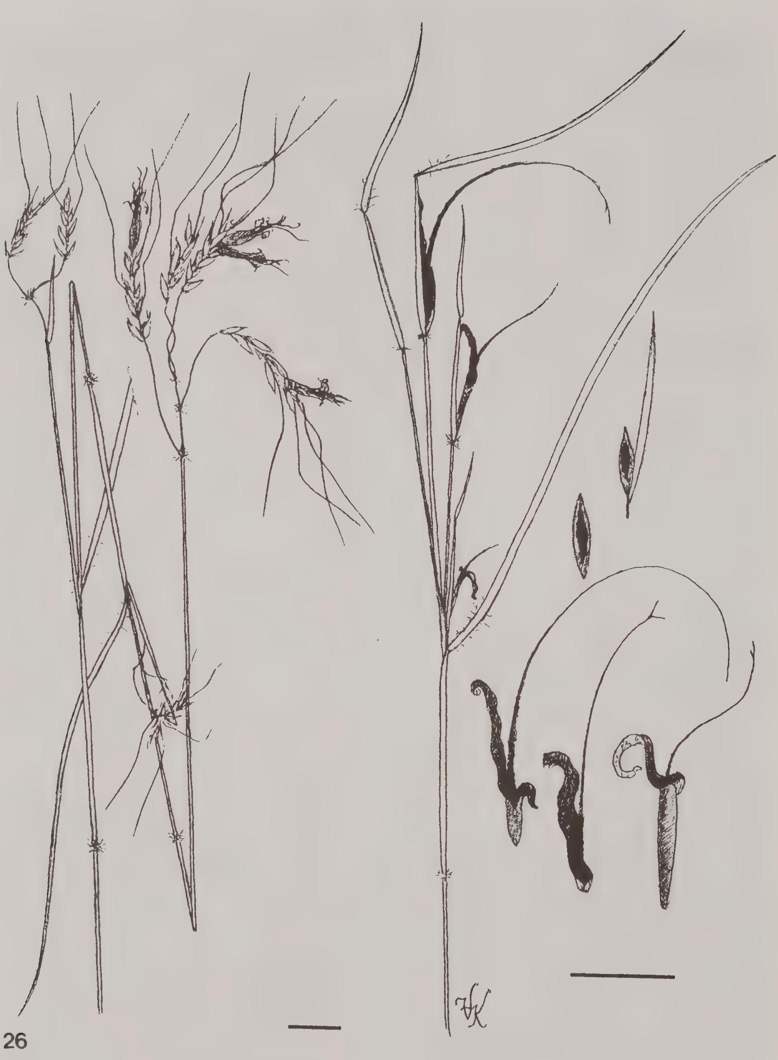

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Fig. 26. Sori of *Sporisorium euclastae* on *Euclasta condylotricha* (type). Habit, and enlarged five sori of different developmental stages. To the left an inflorescence with a few sori of *S. ischaemoides*. Habit. Bars = 1 cm.

Two smut fungi on *Euclasta* (Poaceae)

Euclasta Franch., in the subfamily Panicoideae, tribe Andropogoneae, subtribe Sorghinae, is a small genus of two species in India, tropical Africa and tropical America (Clayton & Renvoize, 1986:344). No smut fungus has been reported on it. Samples of *Euclasta condylotricha*, infected by two smut fungi have been collected recently in Zambia. One forms sori in the spikelets, the other destroys the raceme pairs. The first turned out to be identical with *Sporisorium ischaemoides* (Henn.) Vánky, the second one is a new species:

Sporisorium euclastae Vánky & C. Vánky, **sp. nov.**

Typus in matrice *Euclasta condylotricha* (Steud.) Stapf (det. M. Namaganda, MHU), Zambia, Southern Prov., 70 km S.W. urbe Lusaka, 15°55'29"S, 28°10'0"E, alt. cca. 1060 m.s.m., 16.IV.2001, leg. C., T. et K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 19931! Isotypi in BPI, IMI et MHU.

Sori omia paria racemorum eiusdem inflorescentiae destruentes, longe cylindrici, 0,5–2 x 10–25 mm, peridio crasso, brunneo cooperti, quo longitudinaliter rupto massa atrobrunnea, semiagglutinata usque pulverea sporarum et catervae cellularum sterilium dispersae, sed columella 10–50 mm longa, flagelliformis, centralis, fortuito ramulo apicali, brevi instructa reliqua. *Sporae* maturae singulae, globosae, ovoideae, ellipsoidales usque subpolyedrice parum irregulares, 9–11 x 9,5–13 µm, flavidobrunneae; pariete aequali, cca. 1 µm crasso, dense echinulato, imago obliqua sporae serrulata. *Cellulae steriles* in catervis irregularibus, cellulae singulae forma magnitudine variae, subglobosae, ellipsoidales vel irregulares, lateribus deplanatis, cellulae globoideae earum diametro 5–12 µm, hyalinae; pariete aequali, cca. 0,8 µm crasso, levi, contentu homogeneo, cum 1(–2) guttula oleosa.

Sori (Fig. 26) destroying all raceme-pairs in the inflorescence, long cylindrical, 0.5–2 x 10–25 mm, covered by a thick, brown peridium which ruptures longitudinally and the dark brown, semi-agglutinated to powdery mass of spores and groups of sterile cells is scattered. A 10–50 mm long, flagelliform, central columella, sometimes with a short apical branch remains behind. *Spores* (Figs. 29, 30) when mature single, globose, ovoid, ellipsoidal to subpolyhedrally slightly irregular, 9–11 x 9.5–13 µm, yellowish-brown; wall even, c. 1 µm thick, densely echinulate, spore profile serrulate. *Sterile cells* (Fig. 29) in irregular groups, single cells variable in shape and size, subglobose, ellipsoidal or irregular, with flattened sides, globoid cells 5–12 µm in diameter, hyaline; wall even, c. 0.8 µm thick, smooth, content homogeneous, with 1(–2) oil droplets.

On *Euclasta condylotricha* (Steud.) Stapf; C. Africa (Zambia). Known only from the type collection.

Sporisorium ischaemoides (Henn.) Vánky is known in C. and S. Africa in the spikelets of different *Hyparrhenia* species (subtribe Anthistiriinae). Its occurrence on *Euclasta condylotricha* (subtribe Sorghinae) is unexpected. For description, illustration and discussion of host plant spectrum of this species see Vánky, 2003a:188-190.

A new species of *Sporisorium* on *Schizachyrium* (Poaceae)

I revised the smut fungi of *Schizachyrium* Nees, and recognised five *Sporisorium* species (Vánky, 2003b:36-43). Checking herbarium material, an additional new species was discovered:

Sporisorium blakeanum Vánky, **sp. nov.**

Typus in matrice *Schizachyrium fragile* (R. Br.) A. Camus, Australia, Queensland, N. urbe Hughenden, Poison Creek, 10.IV.1935, leg. S.T. Blake 8528. Holotypus in BRIP 7804!, isotypi in BPI 179806, IMI 43217! et in HUV 19964!

Sori racemos destruentes, fusiformes, 0,5–1,5 x 15–25 mm, spatheolo tubuliformi perfecte obtecti et peridio etiam satis crasso, flavidobrunneo, fissuris multis brevioribus vel longioribus praedito cooperti. Peridium, propter auctum continuum sori in tubo spatheoli relative brevi, rete complicatum, irregulare, cum foraminibus multis irregularibus instructam evadens. Intus in spatheolo et peridio irregulariter aperto, massa nigra, granulosopulverea glomerulorum sporarum et columella longa, centralis, filiformis, plerumque torta convenienetes. *Glomeruli sporarum* satis regulares, globosi, subglobosi, ovoidei, ellipsoidales, raro parum irregulares, (40–)50–70(–90) x 50–90(–100) µm, rubrobrunnei, e paucis decem sporarum pressu valido separabilium compositi. *Sporae* dimorphae. Sporae externae rotundae usque subpolyedrice irregulares, 11–18,5 x 15–20(–21,5) µm, mediocriter rubrobrunneae, cum maculis nonnullis magis, conspicuis, irregularibus, flavidobrunneis, propter parietem irregulariter incrassatum, usque ad 0,5–2(–2,5) µm crassum in angulis maxime incrassatum; superficies libera cellularum externarum pariete cca. 1,5 µm crasso spinis incluis 0,5–0,8 µm altis, obtusis, in visu superficiali sicut verrucae irregulares, sparse usque modice dense dispositae apparentibus; imago obliqua sporarum leniter serrulata. Sporae internae rotundae, subpolyedrice irregulares, sporis externis magnitudine obiter aequales, subhyalinae vel flavidobrunneo tinctae; pariete aequali, tenui, 0.3–0.5 µm, levi. *Cellulae steriles* nullae.

Sori (Fig. 33) destroying the racemes, fusiform, 0.5–1.5 x 15–25 mm, completely hidden by the tubuliform spatheole and also covered by a rather thick, yellowish-brown peridium, on which numerous, shorter or longer fissures appear. Due to the continued growth of the sorus within a relatively short tube of spatheole, the peridium becomes a crinkled, irregular net with numerous, irregular openings. Inside the spatheole and the irregularly opened peridium, there is a black, granular-powdery mass of spore balls and a long, central, filiform, usually twisted columella. *Spore balls* (Figs. 31, 32) rather regular, globose, subglobose, ovoid, ellipsoidal, rarely slightly irregular, (40–)50–70(–90) x 50–90(–100) µm, reddish-brown, composed of a few tens of spores which separate by hard pressure. *Spores* (Figs. 31, 32) dimorphic. Outer spores rounded to subpolyhedrally irregular, 11–18.5 x

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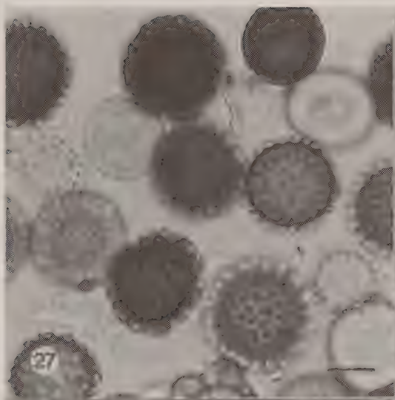
Figs. 27, 28. Spores and sterile cells of *Tilletia acroceratis* on *Acroceras macrum*, in LM and in SEM (type).

Figs. 29, 30. Spores and sterile cells of *Sporisorium euclastae* on *Euclasta condylotricha*, in LM and in SEM (type).

Figs. 31, 32. Spore balls and spores of *Sporisorium blakeanum* on *Schizachyrium fragile*, in LM and in SEM (type). In the SEM picture, the smooth spore wall of the contact sides of the outer spores, and of the inner spores is evident, where one spore is missing from the spore ball. Bars = 10 µm.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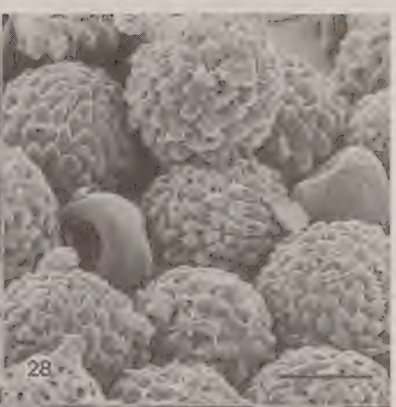
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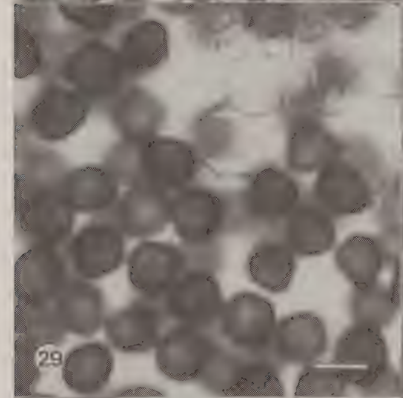
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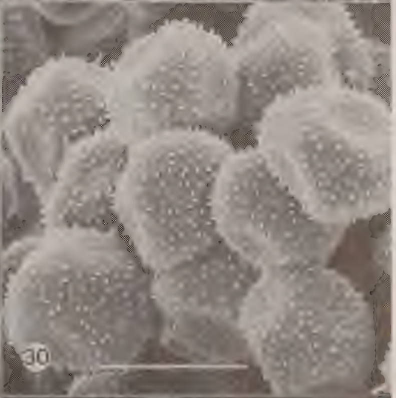
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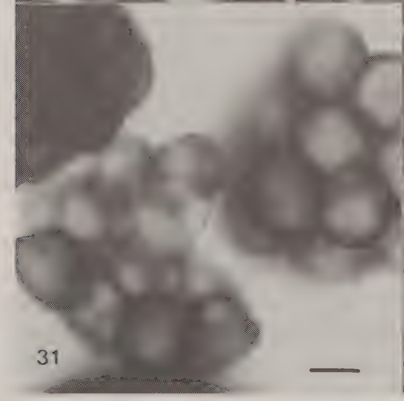
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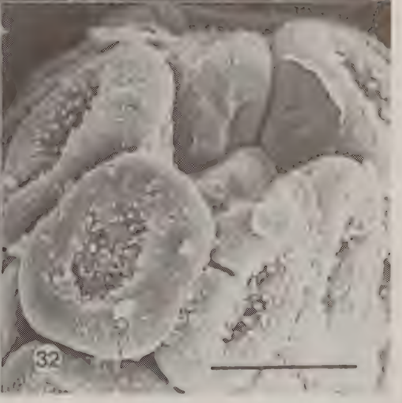
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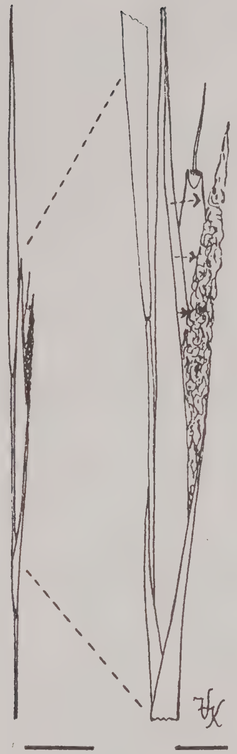

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Fig. 33. A sorus of *Sporisorium blakeanum* in the inflorescence of *Schizachyrium fragile* (type), hidden by the tubuliform spatheole, and covered by a thick, crinkled peridium with irregular openings. To the left, the spatheole is opened (habit). To the right, the sorus is somewhat lifted out from the spatheole to show the typical peridium (enlarged).Bars = 1 cm for habit, and 3 mm for the detail drawing.

15–20(–21.5) µm, medium reddish-brown, with several, large, evident, irregular, yellowish-brown spots, due to the irregularly thickened wall, which may be 0.5–2(–2.5) µm thick, thickest at the angles; free surface of the outer spores c. 1.5 µm thick, including the 0.5–0.8 µm high, blunt spines, which in surface view appear as sparsely to moderately densely situated, irregular warts, spore profile finely serrulate. Inner spores rounded, subpolyhedrally irregular, about the size of the outer spores, subhyaline or yellowish-brown tinted; wall even, thin, 0.3–0.5 µm, smooth. No *sterile cells*.

On *Schizachyrium fragile* (R. Br.) A. Camus; Australia. Known only from the type collection

Sporisorium blakeanum is closest to *S. zambianum* Vánky (type on *Schizachyrium exile* (Hochst.) Pilger, Zambia), from which it differs in the structure of the peridium, and especially in the shape and size of spore balls and spores, as well as the thickness and ornamentation of the spore walls. The spore balls in *S. zambianum* are of variable shape and measure 30–50 x 40–60 µm. The spores are more angular, measure 9–15 x 10.5–17 µm, the free surface of the outer spores is prominently echinulate, provided with 1–2 µm high spines; inner spores are light brown, finely, sparsely punctate-verrucose.

Etymology: This species is named in honour of the outstanding Australian botanist, Stanley T. Blake (1911–1973), with main interest in the Poaceae, an enthusiastic collector not only of healthy plants but also diseased ones, among them also this smut fungus.

A new *Ustilago* species on *Andropogon* (Poaceae)

Zundel (1930) revised the smut fungi of *Andropogon* and recognised 76 species. Since 1930, the classification of both the grasses and the smut fungi has changed considerably. Many "*Andropogon*" species in Zundel's paper do not belong to this genus any more, and many smut fungi do not belong to the genus under which they were treated by Zundel. Surprisingly few *Ustilago* species occur on *Andropogon*. However, a very typical one was found in Herb. WSP, under the name of *Ustilago dieteliana* Henn., which turned out to be a new species:

Ustilago duranii Vánky, sp. nov.

Typus in matrice *Andropogon semiberbis* (Nees) Kunth, Mexico, Chihuahua State, Creel, Monte Gallegos (Padre Gallegos) supra pag. Urique, cca. 27°38' N, 107°50' W, 12.X.1969, R. Durán (sub *U. dieteliana*), WSP 58571!

Sori in foliis supremis 1–2 surculorum sterilium, telas inter venas foliorum destruentes et earum vicem massa nigra, semiagglutinata usque pulverea sporarum implentes. Sori protrudentes a vagina folii postremi intacti, 2–3 mm lati, 6–8 cm longi, primum epidermide obtecti, quo discesso massam sporarum patefacientes, qua dissipata telas vasculares sicut filamenta longa, plerumque torta relinquentes. Apiculi foliorum affectorum tantum intacti manentes. *Sporae* globosae, subglobosae, ovoideae, ellipsoidales, 10,5–13,5 x 11–15(–16) µm, mediocriter atro-flavidobrunneae; pariete aequali vel parum inaequali, 1–2,5 µm crasso, verrucis dense distributis, satis altis, confluentibus, lineas irregulares et reticulos tenues incompletos vel completos formantibus; imago obliqua sporarum grosse undulata usque denticulata.

Sori (Fig. 34) in the uppermost 1–2 leaves of sterile shoots, destroying and replacing the tissues between the leaf-veins with a black, semi-agglutinated to powdery mass of spores. Sori protruding from the last healthy leaf-sheath, 2–3 mm wide, 6–8 cm long, first covered by the epidermis which flakes away, liberating the spore masses which are scattered, leaving behind fascicles of vascular tissues as long, often curled filaments. Only the 1–2 cm long tip of infected leaves remains intact. *Spores* (Fig. 36, 37) globose, subglobose, ovoid, ellipsoidal, 10.5–13.5 x 11–15(–16) µm, medium dark yellowish-brown; wall even or slightly uneven, 1–2.5 µm thick, provided with densely situated, rather high, confluent warts forming irregular rows and a fine, incomplete or complete reticulum; spore profile roughly wavy to denticulate.

On *Andropogon semiberbis* (Nees) Kunth; North America (Mexico). Known only from the type collection.

Ustilago duranii resembles *U. dieteliana* Henn. (type on *Tripsacum dactyloides* (L.) L.). However, in *U. dieteliana* the spores are 9.5–13(–14) µm long, the spore wall is 1–1.5 µm thick, provided with finer warts which often fuse in small groups or short, irregular rows, without forming meshes.

Etymology: This fungus is named in honour of Dr. Ruben Durán, outstanding North American ustilaginologist, author of numerous papers and the books The Genus *Tilletia* (1961) and Ustilaginales of Mexico (1987). He was also a keen collector of smut fungi and, among others, collected this species.

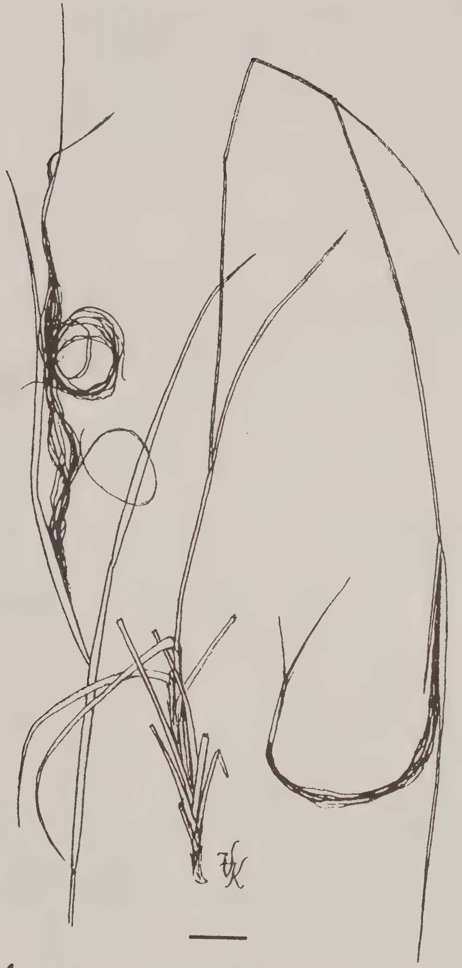
A new species of *Microbotryum* (Microbotryales)

Seven, morphologically different *Microbotryum* species have been recognised on members of Polygonaceae, Sect. Persicaria, (comp. Vánky & Oberwinkler, 1994, and see the key in Vánky, 1998a:55). All these species have reticulate spores and sori in the flowers. From the comprehensive infection studies of Liro (1924:188-240), a strict host specificity is evident, not only for these, but also for several, morphologically more or less identical smuts of Polygonaceae (comp. also Ciferri, 1931:36-42). It seems that these smuts represent a complex in which they are on different levels of speciation. For example, there are host specific smuts which hardly can be differentiated by spore morphology from *Microbotryum reticulatum* (Liro) R. Bauer & Oberw. (type on *Polygonum lapathifolium* L., Finland), e.g. *Ustilago ravida* Liro (type on *P. senegalense* Meisner, Rwanda), or *U. controversa* Cif. (type on *P. pennsylvanicum* L., U.S.A.). Other species are morphologically different, e.g. *M. radians* (Vánky & Oberw.) Vánky (type on *P. careyi* Olney, U.S.A), *M. prostratum* (Vánky & Oberw.) Vánky (type on *P. prostratum* R. Br., Australia), *M. tenuisporum* (Cif.) Vánky (type on *P. acre* H. B. & K., Argentina), and others. A further smut, close to, but different from *M. reticulatum* is:

Microbotryum paucireticulatum Vánky, **sp. nov.**

Typus in matrice *Polygonum orientale* L., India, Lakhipur, Cachar, 3.III.1942, S. Choudhury. Holotypus in Herbario Ustil. Vánky, HUV 17349!, isotypus in HCIO (sicut *Ustilago utriculosa*).

Sori in omnibus floribus inflorescentiae eiusdem, tumefacti, deformati, perianthio cooperti, massa brunneoviolacea, pulverea sporarum repleti. *Sporae* globosae, subglobosae usque late ellipsoidales vel ovoideae, raro elongatae, 10,5–13,5 x 11–14,5(–16) µm, violaceotinctae pallide rubrobrunneae; pariete 1,5–2 µm crasso, aspere reticulato, maculae 2–4 per diametrum sporae, maculae polygonales, (2,5–)3–5(–5,5) µm latae, muri earum cca. 1 µm alti, in visu optical mediano acuti vel subacuti; in SEM interstitium leve, in medio verrucis nonnullis.



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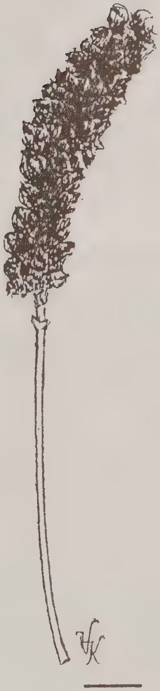

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Fig. 34. Sori of *Ustilago duranii* in the uppermost leaves of two sterile shoots of *Andropogon semiberbis* (type).

Fig. 35. Sori of *Microbotryum paucireticulatum* in the flowers of *Polygonum orientale* (type).

Bars = 1 cm.

Sori (Fig. 35) in all flowers of an inflorescence, swollen, deformed, covered by the perianths, filled with a brownish-violet, powdery spore mass. *Spores* (Fig. 38, 39) globose, subglobose to broadly ellipsoidal or ovoid, rarely elongate, 10.5–13.5 x 11–14.5(–16) µm, violet-tinted light reddish-brown; wall 1.5–2 µm thick, coarsely reticulate, 2–4 meshes per spore diameter, meshes polygonal, (2.5–)3–5(–5.5) µm wide, muri c. 1 µm high, thin, in optical median view acute or subacute; in SEM interspaces smooth with a few small warts in their centre.

On Polygonaceae (Sect. Persicaria): *Polygonum orientale* L.; S. Asia (India). Known only from the type locality.

Microbotryum paucireticulatum is closest to *M. reticulatum,* from which it differs in having somewhat larger spores, larger and fewer meshes per spore diameter and lower muri. The spores of the latter species measure 9–12 x 9–15 µm, are provided with (2–)3–4 meshes per spore diameter, meshes 2–4 µm wide, the muri are 1–1.5 µm high, and the interspaces are coarsely verrucose.

A new species of *Tilletia* on *Eragrostis* (Poaceae)

Three *Tilletia* species are recognised on *Eragrostis*: **1.** ***T. baldratii*** Montemart., **2.** ***T. eragrostidis*** G.P. Clinton & Ricker, and **3.** ***T. transvaalensis*** Zundel. On *Eragrostiella* two *Tilletia* species are known: **1.** ***T. eragrostiellae*** Vánky, C. Vánky & N.D. Sharma, and **2.** ***T. poonensis*** Thirum. & Pavgi. A different smut fungus was discovered in IMI:

Tilletia kenyana Vánky, **sp. nov.**

Typus in matrice *Eragrostis caespitosa* Chiov., Kenya, Makueni, alt. 3500 ft, 16.I.1960, leg. A. Bogdan. Holotypus in IMI 80374!, isotypus in HUV 18141!

Sori ovariis nonnullis vel omnibus spiculorum nonnullorum inflorescentiae eiusdem, ellipsoidales, 0,3–0,5 x 0,8–1 mm, involucris floralibus plus-minus ob-tecti, primo pericarpio obtecti, quo mature irregulariter rupto massam sporarum cellularumque sterilium pallide brunneam, semiagglutinatam ostendentes. *Sporae* globosae, subglobosae, late ellipsoidales, 13–16 x 13–19 µm, pallide flavae usque pallide flavidobrunneae, in diametro sporae verrucis 4–7, subpyramidali-bus, 1,5–2,5(–3) µm altis, obtusis, in visu superficiali conspicuis; imago obliqua sporae propter vaginam hyalinam undulata. *Cellulae steriles* subglobosae, ellipsoidales vel parum irregulares, magnitudine variae, 8–24 x 9–25 µm, hyalinae usque colore flavidobrunneo tinctae; pariete 0,5–1,5 µm crasso, levi.

Sori (Fig. 48) in some or all ovaries of a few spikelets of an inflorescence, ellipsoidal, 0.3–0.5 x 0.8–1 mm, more or less hidden by the floral envelopes, first covered by the pericarp which ruptures irregularly at maturity disclosing the pale brown, semi-agglutinated mass of spores and sterile cells. *Spores* (Figs. 40, 41) globose, subglobose, broadly ellipsoidal, 13–16 x 13–19 µm, pale yellow to pale yellowish-brown, provided with 1.5–2.5(–3) µm high, blunt, subpyramidal warts, 4–7 per spore diameter, seen in surface view, spore profile wavy due to a hyaline sheath. *Sterile cells* (Figs. 40, 41) subglobose, ellipsoidal or slightly irregular, variable in size, 8–24 x 9–25 µm, hyaline to yellowish-brown tinted; wall 0.5–1.5 µm thick, smooth.

On *Eragrostis caespitosa* Chiov.; Kenya. Known only from the type locality.

Two additional smut fungi are present in the type collection: *T. eragrostidis* and *Macalpinomyces spermophorus*.

Key to the *Tilletia* species of *Eragrostis* and *Eragrostiella*

1. Spores reticulate .... ***T. baldratii***
– Spores provided with pointed, subacute or truncate, pyramidal warts 2
2. Spores 40–60(–65) µm, warts 4–8(–9) µm high ....***T. eragrostiellae***
– Spores smaller, warts lower 3
3. Spores 28–40 µm long, warts 2.5–5.5 µm high ....***T. eragrostidis***
– Spores smaller, warts lower 4
4. Spores 18–28 µm long 5
– Spores 13–19 µm long, warts 1.5–2.5(–3) µm high.................***T. kenyana***
5. Spores with 2.5–4 µm high, pointed, pyramidal warts.....***T. transvaalensis***
– Spores with (1.5–)2–2.5 µm high, truncate, pyramidal warts .***T. poonensis***

A third species of *Urocystis* on *Hypoxis* (Amaryllidaceae)

Two *Urocystis* species are known on *Hypoxis*: ***U. hypoxis*** Thaxter (1893:278), type on *H. erecta* L. (= *H. hirsuta* (L.) Coville), USA. It is characterised by spore balls measuring 20–45 x 25–60 µm, composed of (1–)3–10(–15) spores. ***U. thaxteri*** Vánky (2001:270), type on *H. acuminata* Baker, *H. costata* Baker, *H. galpinii* Baker, and *H. rigidula* Baker, South Africa, with spore balls measuring 30–50 x 35–70(–80) µm, composed of (3–)5–25(or more?) spores. A different species is:

Urocystis aurea Vánky, sp. nov.

Typus in matrice *Hypoxis aurea* Lour., India, Maharashtra State, pr. urbem Poona, Lonawala, 7.VIII.1955, leg. S.D. Patil. Holotypus in Herbario Ustil. Vánky, HUV 15599.

Sori in capsulis, vicem seminum massa atrobrunnea, pulverea glomerulorum sporarum implentes. Rarius sori in pedicellis floralibus intumescentias fusiformes producentes. *Glomeruli sporarum* globosi, ovoidei, ellipsoidales usque parum irregulares, 20–32 x 20–40 µm, e sporis 1–6(–8) compositi et strato cellularum sterilium perfecte obtecti. *Sporae* subglobosae, ellipsoidales, elongatae usque subpolyedrice irregulares, 8–12 x 9,5–16 µm, rubrobrunneae. *Cellulae steriles* et forma et magnitudine variae, 6,5–16 µm longae, pallide flavidobrunneae, propter tenuitatem parietis liberi (cca. 0.5 µm), specimina earum aetate superiora collapsae, parietibus contactis crassioribus, cca. 1 µm, levibus.

Sori in the capsules, replacing the seeds with a dark brown, powdery mass of spore balls. More rarely sori on the floral pedicels producing fusiform swellings. *Spore balls* (Fig. 42) globose, ovoid, ellipsoidal to slightly irregular, 20–32 x 20–40 µm, composed of 1–6(–8) spores (1 = 16%, 2 = 33.5%, 3 = 29%, 4 = 16%, 5 = 3.5%, 6 = 1.5%, 7 = 0%, 8 = 0.5%) and a completely investing layer of sterile cells. *Spores* (Fig. 42) subglobose, ellipsoidal, elongated to subpolyhedrally irregular, 8–12 x 9.5–16 µm, reddish-brown. *Sterile cells* (Fig. 42) variable in shape and size, 6.5–16 µm long, pale yellowish-brown, collapsed in old specimens; wall of the free, outer side thin, c. 0.5 µm, the contact walls are c. 1 µm thick, smooth. *Spore germination* results in short holobasidia apically producing 4–8 ellipsoidal basidiospores which fuse in pairs (Gandhe, 1998).

On Amaryllidaceae (Hypoxidaceae): *Hypoxis aurea* Lour.; Asia (India).

It is not unusual that several *Urocystis* species may occur on a certain host plant genus in the Amaryllidaceae. On species of *Ixiolirion* there are two *Urocystis* species known: *U. ixioliri* Zaprom. and *U. nevodovskyi* Schwarzman, both in Asia.

A new species of *Tranzscheliella* on *Sporobolus* (Poaceae)

Twelve species of *Tranzscheliella* are known, producing superficial, naked sori on the stems, more rarely also on axes and branches of the inflorescence of Poaceae. An additional species is:

Tranzscheliella laevispora Vánky, **sp. nov.**

Typus in matrice *Sporobolus agrostoides* Chiov., Kenya, Thomson's Fall Schoob, alt. cca. 7500 ft, 28.VII.1950, R.W. Barney. Holotypus in Herbario Ustil. Vánky, HUV 15444!

Sori in superficie telarum plantae nutrientis (vaginae foliorum?), strias nigrobrunneas, pulvereas, confluentes, usque 10 cm longas vel longiores formantes. *Sporae* globosae, subglobosae, ellipsoidales, saepe latere uno deplanatae et tunc semiglobosae vel cupulatae, cca. 3 µm latae, in visu superficiali 4–5,5 x 4,5–6,5 µm, rubrobrunneae; pariete cca. 0,4 µm crasso, latere uno parum tenuiore, levi.

Sori on the surface of host tissues (leaf sheath?), forming blackish-brown, powdery, confluent striae, up to 10 cm long or longer. *Spores* (Fig. 46, 47) globose, subglobose, ellipsoidal, often flattened on one side and then hemiglobose or cup-shaped, c. 3 µm wide, in surface view 4–5.5 x 4.5–6.5 µm, reddish-brown; wall c. 0.4 µm thick, somewhat thinner on one side, smooth.

On *Sporobolus agrostoides* Chiov.; E. Africa (Kenya). Known only from the type collection.

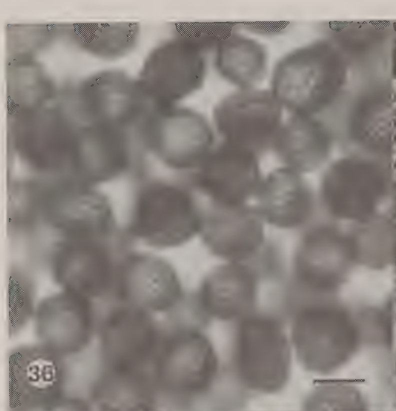
Tranzscheliella laevispora differs from *T. hypodytes* and related species, especially in having smooth spores and hemispherical or cup-shaped spores as seen in SEM.

On the fragmentary material at hand, the place of the sori could not be established with certainty, and the host plant identity could not be verified.

Figs. 36, 37. Spores of *Ustilago duranii* on *Andropogon semiberbis*, in LM and in SEM (type).

Figs. 38, 39. Spores of *Microbotryum paucireticulatum* on *Polygonum orientale*, in LM and in SEM (type).

Figs. 40, 41. Spores and sterile cells of *Tilletia kenyana* on *Eragrostis caespitosa*, in LM and in SEM (type). Bars = 10 µm.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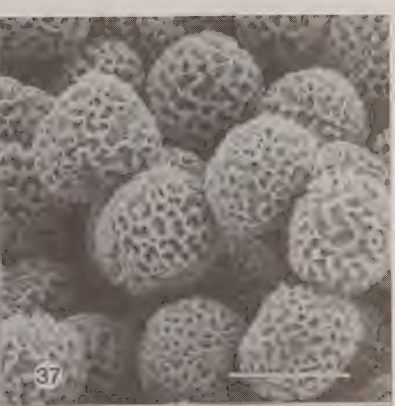
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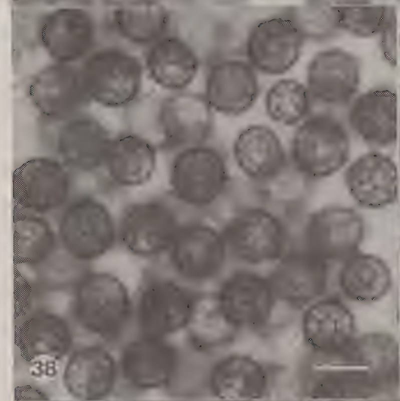
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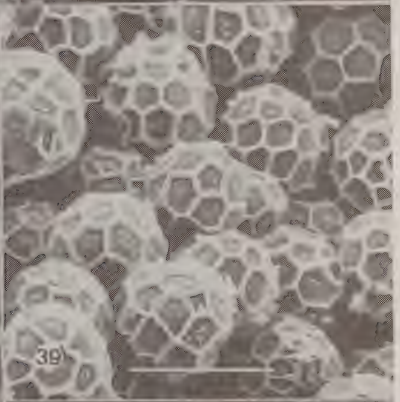
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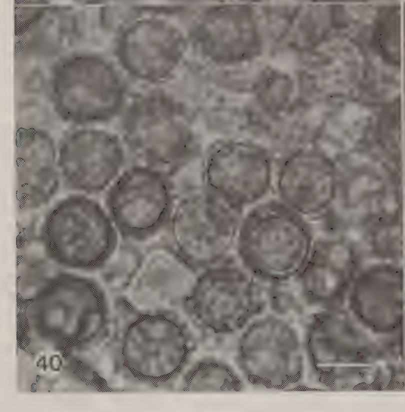
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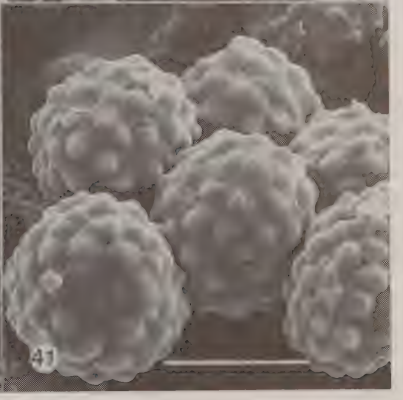
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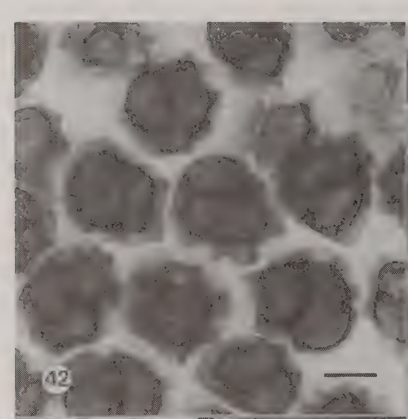
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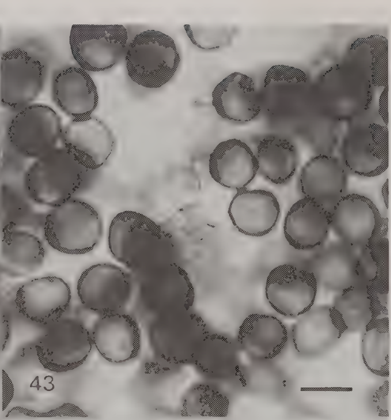
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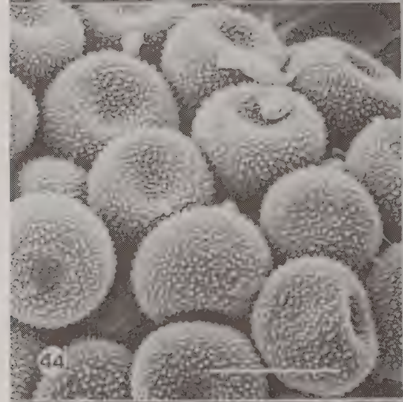
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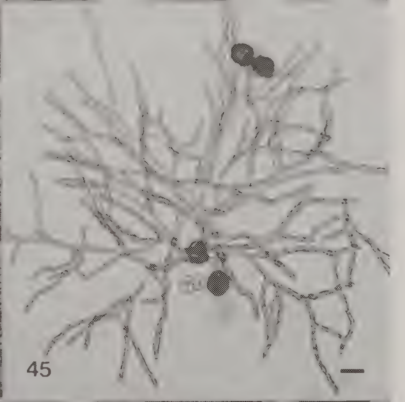
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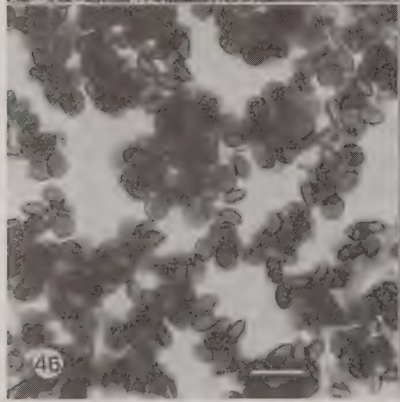
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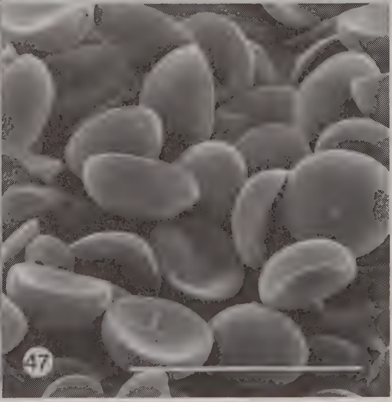
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The smut fungi of *Urochloa*, compared with those of *Brachiaria*, *Eriochloa* and *Yakirra* (Poaceae)

Urochloa P. Beauv., with 12 species in the Old World tropics, mainly in Africa, belongs to the subfamily Panicoideae, tribe Paniceae, subtribe Setariinae (Clayton & Renvoize, 1986:284). It is closely related to *Brachiaria* (c. 100 spp.), *Eriochloa* (c. 30 spp.) and *Yakirra* (6 spp.). On ***Brachiaria*** gradually I recognised ten smut fungi (Vánky, 1997b:138-141, 2000a:173-175, 2002a:377, Vánky & Shivas, 2003:246-249): **1. *Eballistra brachiariae*** (Viégas) R. Bauer, Begerow, A. Nagler & Oberw., **2. *Macalpinomyces brachiariae*** Vánky, C. Vánky & R.G. Shivas, **3. *M. ordensis*** (R.G. Shivas & Vánky) R.G. Shivas & Vánky, **4. *M. tanakae*** (S. Ito) Vánky, **5. *Sporisorium cryptum*** (McAlpine) Vánky, **6. *S. ovarium*** (Griffiths) Vánky, **7. *S. serratum*** (L. Ling) Vánky (= *S. africanum*), **8. *Tilletia brachiariae*** (Pavgi & Thirum.) Vánky, **9. *T. mauritiana*** Vánky, and **10. *Ustilago operta*** Syd., P. Syd. & Butler. On ***Eriochloa*** three smut fungi are known: **1. *Sporisorium eriochloae*** Vánky, **2. *S. mixtum*** (Massee) Vánky, and **3. *Tilletia brachiariae*** (Pavgi & Thirum.) Vánky. On ***Yakirra*** only one smut fungus is known: ***Sporisorium cryptum*** (McAlpine) Vánky. On ***Urochloa*** seven smut fungi have been reported. These were studied, compared to each other and to the smut fungi on *Brachiaria*, *Eriochloa* and *Yakirra*. It turned out that *Melanotaenium urochloae* M.S. Patil is a synonym of *Eballistra brachiariae, Sphacelotheca serrata* L. Ling is *Sporisorium africanum* (Syd. & P. Syd.) Vánky. *Ustilago verecunda* Syd., and *U. urochloana* Zundel are synonyms of *Sporisorium ovarium*. On *Urochloa* four smut fungi could be recognised:

1. *Eballistra brachiariae* (Viégas) R. Bauer, Begerow, A. Nagler & Oberw., 2001:423.

Melanotaenium brachiariae Viégas, 1944:748. — Type on *Brachiaria plantaginea* (Link) Hitchc., Brazil, Est. de São Paulo, Mogí-Mirim, Faz. Emílio Spina, 27.II.1941, A.P. Viégas, IACM; isotypes HCIO 11662!, HUV 15410!

Tolyposporella brachiariae Mundkur & Thirumalachar, 1946:5. — Type on *Brachiaria distachya* (L.) Haines, India, Bangalore, Karnataka,

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Fig. 42. Spores of *Urocystis aurea* on *Hypoxis aurea*, in LM (type).

Figs. 43, 44. Spores and sterile cells of *Sporisorium arundinellae-pumilae* on *Arundinella pumila*, in LM and in SEM (type).

Fig. 45. Spore germination of *Sporisorium arundinellae-pumilae* (on WA, in 5 days, at room temp.; stained with cotton-blue; type).

Figs. 46, 47. Spores of *Tranzscheliella laevispora* on *Sporobolus agrostoides*, in LM and in SEM (type). Bars = 10 µm.

14.II.1942, M.J. Thirumalachar, HCIO 10339-103341! (as "14.XII.1942"). (syn. by Vánky, 1997b:139).

Melanotaenium echinochloae M.S. Patil, 1992:180. — Type on "*Echinochloa* sp." (= misnamed *Brachiaria distachya* (L.) Haines, teste K. Vánky), India, Maharashtra State, Kolhapur, Shivaji University Campus, 8.X.1978, M.S. Patil, HCIO 30109; isotype HUV 15494! (syn. by Vánky, 1997b:139).

Melanotaenium urochloae M.S. Patil, 1992:180. — Type on *Urochloa trichopus* (Hochst.) Stapf (= misnamed *U. panicoides* P. Beauv., teste K. Vánky), India, Maharashtra State, Kolhapur, 19.XII.1979, A.R. Kulkarni, HCIO 30110; isotype HUV 17509! (syn. nov.).

For description see Vánky, 1997b:139.

On *Brachiaria distachya* (L.) Stapf, *B. piligera* (F. Muell. ex Benth) Hughes (*Urochloa piligera* (F. Muell. ex Benth) R. Webster), *B. plantaginea* (Link) Hitchc., *Urochloa panicoides* P. Beauv., *U. trichopus* (Hochst.) Stapf; S. Asia (India), Africa (Zimbabwe), Australia, South America (Brazil).

2. *Macalpinomyces pretoriensis* (Pole-Evans) Vánky, 2003b:57.

Ustilago pretoriensis Pole-Evans, in H. & P. Sydow, Ann. Mycol. 12:263, 1914. — *Sphacelotheca pretoriensis* (Pole-Evans) Zundel, 1938:301. — *Sporisorium pretoriense* (Pole-Evans) Vánky, 1998c:9, nom. herb. — Type on *Panicum helopus* Trin. var. *glabrescens* (K. Schum.) Stapf (*Urochloa panicoides* P. Beauv.), South Africa, Transvaal, Pretoria, 20.III.1914, A.O.D. Mogg, PREM 7408; isotype HUV 18004!

For its description see Vánky, 2003b:57.

On *Panicum maximum* Jacq., *Urochloa brachyurus* (Hack.) Stapf, *U. panicoides* P. Beauv. (*U. helopus* (Trin.) Stapf; *Panicum helopus* Trin. var. *glabrescens* (K. Schum.) Stapf), *U. trichopus* (Hohst.) Stapf; Africa (Malawi, South Africa, Zambia, Zimbabwe).

3. *Sporisorium africanum* (Syd. & P. Syd.) Vánky, **comb. nov.**

Basionym: *Sorosporium africanum* H. & P. Sydow, Ann. Mycol. 7:544, 1909. — Type on *Panicum trichopodon* A. Rich. (= *Urochloa trichopus* (Hochst.) Stapf), Portuguese East Africa [Mozambique], 18.IV.1908, C.W. Howard; isotypes BPI 179411 & 179412, PREM 7631.

Sphacelotheca serrata L. Ling, 1953b:183. — *Sporisorium serratum* (L. Ling) Vánky, 1997b:140. — Type on *Brachiaria serrata* (Thunb.) Stapf, Nyasaland [Malawi], Lilongwe, IX.1950, G. Jackson, IMI 44074!; isotype HUV 17372! (syn. nov.).

For its description see Vánky, 1997b:140 (as *Sporisorium serratum*).

On *Brachiaria serrata* (Thunb.) Stapf, *Urochloa oligotricha* (Fig. & De Not.) Henrard (*U. bolbodes* (Steud.) Stapf), *U. trichopus* (Hochst.) Stapf (*Panicum trichopodon* A. Rich.); Africa (Malawi, Mozambique, S. Africa).

4. *Sporisorium ovarium* (Griffiths) Vánky, 1997b:138.

Sorosporium ovarium Griffiths, 1907:209. — Lectotype (designated by Zundel, 1953:68) on *Panicum caespitosum* Swartz (= *Brachiaria reptans* (L.) Gard. & C.E. Hubb.), Mexico, Hidalgo, Dublan, 9.IX.1905, D. Griffiths, BPI 180088!

Sphacelotheca diplospora (Ellis & Everh.) G.P. Clinton var. *verruculosa* G.P. Clinton, 1906:27. — Type on *Panicum* sp. (= *Brachiaria meziana* Hitchc., comp. Ling, 1953b:191), Mexico, near Mexico City, Lecheria, 5.VII.1904, C.G. Pringle, NHES; isotypes BPI 177481, HUV 16754! (syn. by Ling, 1953b:191, confirmed).

Ustilago verecunda H. Sydow, 1935:231. — *Sorosporium verecundum* (Syd.) Zundel, Bothalia 3:304, 1938. — Type on *Urochloa helopus* (Trin.) Stapf, South Africa, Transvaal, Pretoria, Wonderboom, Siding, 27.II.1931, A.O.D. Mogg, PREM 26609; isotype HUV 18208! (syn. nov.).

Sorosporium brachiariae J.C. Hopkins, 1938:109 & 126. — Type on *Brachiaria brizantha* (A. Rich.) Stapf, Rhodesia [Zimbabwe], Salisbury [Harare], 26.I.1932, J.C. Hopkins, Herb. Dept. Agricult. Southern Rhodesia no. 1860; isotypi in PREM 30370! BPI 179468! & 195141. (syn. by Ling, 1953b:191, confirmed).

Ustilago urochloana Zundel, 1943:166. — Type on *Urochloa trichopus* (Hochst.) Stapf, South Africa, Transvaal, Crocodile River, Brown's Kuil Drift, 8.VI.1921, A.O.D. Mogg, PREM 20690; isotypes BPI 168742!, HCIO, HUV 15403! (syn. nov.).

Sorosporium brachiariae-ramosae Ramakrishnan, 1952:113. — Type on *Brachiaria ramosa* Stapf, India, Tamil Nadu, Coimbatore, Pollachi, 20.VIII.1912, S. Sundararaman, HCIO 19814!; isotypes IMI 56705, HUV 17272! (syn. by Vánky, 1997b:139).

For its description see Vánky, 1997b:138.

On *Brachiaria brizantha* (A. Rich.) Stapf, *B. lata* (Schum.) C.E. Hubb., *B. meziana* Hitchc., *B. piligera* (F. Muell.) Hughes, *B. ramosa* Stapf, *B. reptans* (L.) Gard. & C.E. Hubb., *B. xantholeuca* (Hackel ex Schinz) Stapf, *Panicum maximum* Jacq., *Urochloa fasciculata* (Sw.) R. Webster, *U. mosambicensis* (Hack.) Dandy (*U. pullulans* Stapf var. *mosambicensis* Hack.), *U. panicoides* P. Beauv. (*U. helopus* (Trin.) Stapf), *U. trichopus* (Hochst.) Stapf, *Urochloa* sp.; Africa (Botswana, Cape Verde I., Malawi, South Africa, Zambia, Zimbabwe), S. Asia (India), Australia, N. & C. America (Mexico, Panama).

Key to the smut fungi of *Brachiaria, Eriochloa, Urochloa* and *Yakirra* (*M. = Macalpinomyces, S. = Sporisorium*)

1. Sori in the leaves and stems .... ***Eballistra brachiariae***
– Sori in ovaries, flowers or spikelets 2

2. Spores more than 13 µm long. Sori in ovaries 3
– Spores less than 15 µm long. Sori in ovaries, flowers or spikelets 4
3. Spores 19–24(–26) µm long.. ***Tilletia brachiariae***
– Spores 13.5–18.5 µm long .... ***Tilletia mauritiana***
4. Sori in some ovaries or flowers of an inflorescence. Sterile cells abundant between the spores...5
– Sori in all ovaries or flowers of an inflorescence. Sterile cells few or absent 8
5. Spores 8–13 µm long 6
– Spores 7–11 µm long 7
6. Sori inconspicuous, up to 2 mm long. Spores densely, evidently echinulate. Spore profile serrate... ***M. tanakae***
– Sori hypertrophied, up to 40 mm long. Spores prominently, moderately densely echinulate. Spore profile serrulate....... ***M. pretoriensis***
7. Sori inconspicuous, up to 1 mm long. Spores densely, low verrucose-echinulate. Spore profile smooth to finely wavy................. ***M. brachiariae***
– Sori hypertrophied, up to 5 mm long. Spores sparsely, evidently echinulate. Spore profile finely, sparsely serrulate ....***M. ordensis***
8(4). Columella and spore balls absent. Sori destroying the inner floral organs, often also the basal part of the floral envelopes......***Ustilago operta***
– Columella and spore balls present, at least in young sori. Sori otherwise..9
9. Sori 5–10 mm long. Spores expressly dimorphic. Outer spores in a ball mamillate.. ***S. eriochloae***
– Sori usually much shorter. Spores not or only slightly dimorphic, not mamillate 10
10. Spores 6.5–9 µm long; wall uneven, 0.5–1.5 µm thick, smooth to punctate-verruculose .... ***S. africanum***
– Spores larger, wall evenly thick 11
11. Spores 8–10.5 µm long, finely punctate to verruculose. Spore profile smooth.. ***S. cryptum***
– Spores larger, densely verrucose-echinulate. Spore profile wavy to finely serrulate...12
12. Spores 8–12(–13) µm long ....***S. ovarium***
– Spores 9.5–15 µm long ....***S. mixtum***

The smut fungi of *Arundinella* (Poaceae)

Arundinella Raddi, with c. 50 species in the tropics and subtropics, mainly in Asia, belongs to the tribe Arundinelleae of the subfamily Panicoideae (Calyton & Renvoize, 1986:316). At least ten smut fungi have been reported on *Arundinella*: **1. *Macalpinomyces effusus*** (Syd. & P. Syd.) Vánky, **2. *Melanotaenium arundinellae*** M.S. Patil, **3. *M. tuberculatae*** M.S. Patil, **4. *Sorosporium arundinellae*** Syd. & P. Syd., **5. *S. concelatum*** L. Ling,

6. *Tilletia arundinellae* L. Ling, **7. *Ustilago arundinellae*** Bref., **8. *U. arundinellae-hirtae*** S. Ito, **9. *U. pimprina*** Thirum. & Pavgi, and **10. *U. shimadae*** Sawada. The recognised eight species, including a new one, are:

1. *Macalpinomyces effusus* (Syd. & P. Syd.) Vánky, 1997a:129.

Ustilago effusa Syd. & P. Syd., in H. & P. Sydow & Butler, 1906:425. — *Endosporisorium effususm* (Syd. & P. Syd.) K. Vánky, 1995:212. — Type on *Andropogon muricatus* Retz. (= *Vetiveria zizanioides* (L.) Nash), India, Assam, Sylhet Distr., Kanaighat, 21.V.1905, E.J. Butler 450. Holotype HCIO 450, isotypes BPI 160327, 160328, 188930, HUV 16416.

M. effusus was also collected on *Arundinella bengalensis* (Spreng.) Druce. It is questionable if the healthy inflorescence of *A. bengalensis* and the smutted plants in HCIO 1417 represent the same species. If I accept it, I do it only because this collection was made by E.J. Butler, an outstanding botanist and mycologist, who knew very well the grasses and their smuts of India, and also collected the type specimen of *M. effusus*.

For description see Vánky, 1995:212 (as *Endosporisorium effusum*).

On *Arundinella bengalensis* (Spreng.) Druce, and *Vetiveria zizanioides* (L.) Nash; S. Asia (India).

2. "*Melanotaenium*" *arundinellae* M.S. Patil, 1992:179.

Type on *Arundinella setosa* Trin., India, Maharashtra State, Sangli, XI.1985, S.R. Yadav, HCIO 30107!

Sori in the leaves as lead coloured angular or linear, nonerumpent spots, c. 1 mm wide and up to 15 mm long. *Spores* embedded in the leaf tissue in the intercellular spaces of mesophyll cells, globose, subglobose, ovoid to slightly irregular, 6–9.5 x 7–11 µm, yellowish-brown; wall even or slightly uneven, 0.8–1.5 µm thick, smooth.

On *Arundinella setosa* Trin.; S. Asia (India).

3. "*Melanotaenium*" *tuberculatae* M.S. Patil, 1992:180.

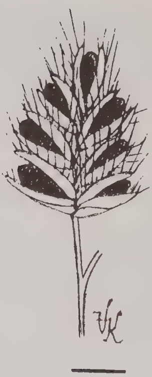
Type on *Arundinella tuberculata* Munro, India, Maharashtra State, Kolhapur, Shivaji University Campus, 15.XII.1985, M.S. Patil, HCIO 30108!

Sori in the leaves as lead coloured spots, 1–5 x 2–15 mm or larger by confluence. *Spores* embedded in the leaf tissue, usually irregularly subpolyhedral, rarely subglobose or ellipsoidal, 8–13 x 9–16 µm, dark reddish-brown; wall uneven, (1–)2–4(–5) µm thick, smooth.

On *Arundinella tuberculata* Munro; S. Asia (India).

4. *Sporisorium arundinellae* (Bref.) Vánky, **comb. nov.**

Basionym: *Ustilago arundinellae* Brefeld, Unters. Gesammtgeb. Mykol. 12:108, 1895. — *Sphacelotheca arundinellae* (Bref.) Mundkur, 1939:113. — Type on *Arundinella* sp., India, West Bengal, Calcutta, ?, comm. Cunningham.



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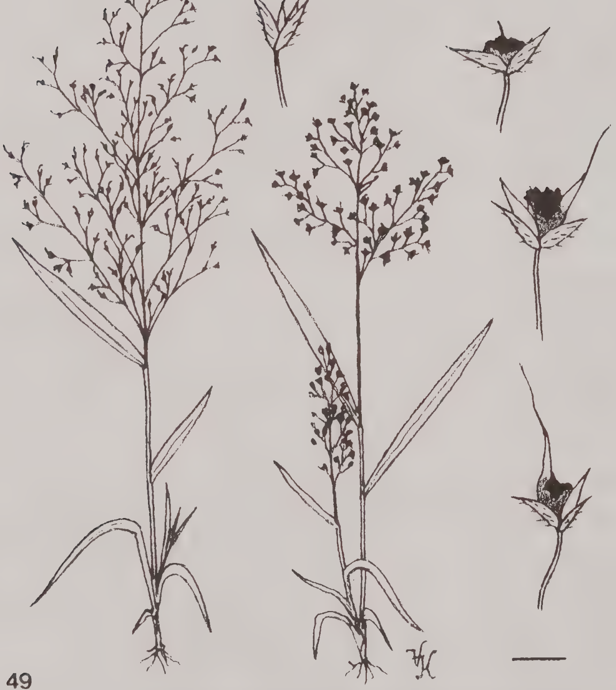

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Fig. 48. Sori of *Tilletia kenyana* in all ovaries of a spikelet of *Eragrostis caespitosa* (type).
Bar = 1 mm.

Fig. 49. Sori of *Sporisorium arundinellae-pumilae* on *Arundinella pumila* (type). To the left a healthy plant. Enlarged a healthy and three infected spikelets.
Bars = 1 cm for the habit, and 2 mm for the detail drawings.

According to Brefeld's incomplete original description, the *sori* are in the ovaries, the *spores* are smooth, rounded, brown, 8–9 µm in diameter. *Spore germination* results in 4-celled basidia on which ellipsoidal basidiospores are produced on sterigmata (Brefeld, 1895:108, Pl. VI, figs. 19-23).

Fortunately, Mundkur (1939:113) studied the type specimen before it was destroyed in Berlin, and gave a more complete description for it, under the name of *Sphacelotheca arundinellae:* "Ovaricolous; sori 2.5–3 mm long, covered by a firm false membrane consisting of hyaline, globose, smooth, sterile cells; columella slightly coiled at the top. Spores mostly globose, some round and flattened when they have a concavity on both sides at the centre which looks like a large vacuole; mostly Vandyke Brown (Ridgway) but those that are flat, Cameo Brown; epispore markedly thick with a smooth edge, with surface minutely pitted; diameter 7–10 µ with a mean of 8.9 µ."

On *Arundinella* sp.; S. Asia (India). Known only from the type locality.

Sorosporium concelatum L. Ling belongs to the genus *Sporisorium*. The name *Sporisorium concelatum* being occupied, a new name is proposed for this smut:

5. *Sporisorium arundinellae-nepalensis* Vánky, **nom. nov.**

Replacing *Sorosporium concelatum* L. Ling, Lloydia, 14:106, 1951 (not *Sporisorium concelatum* (Zundel) M. Piepenbring, 2002:109, type on *Ischaemum latifolium*). — Type on *Arundinella nepalensis* Trin., Australia, New South Wales, Gilgandra, VII.1928, without name of collector, BPI 179453!

Sori in the ovaries, infecting all the spikelets in a panicle, 2–3 mm long, oblong, tapering at both ends, concealed by the glumes, each enclosed in a greenish peridium of host tissue and fungal cells. *Spore balls* subglobose to oblong or irregular, 25–65 x 30–70(–100) µm, reddish-brown to opaque, rather permanent. *Spores* irregularly subpolyhedral or polyhedral, 5.5–9 x 6.5–10.5 µm, dimorphic; peripheral spores deep cinnamon brown, densely verruculose on free surface, inner spores subhyaline to yellowish-brown, apparently smooth to finely punctate. No sterile cells between the spores.

On *Arundinella nepalensis* Trin.; Australia. Known only from the type collection.

6. *Sporisorium arundinellae-pumilae* Vánky, **sp. nov.**

Typus in matrice *Arundinella pumila* (Hochst.) Steud. (det. S. Karthikeyan, BSI), India, Maharashtra State, 2 km N. oppid. Mahabaleshwar, 17°56' N, 73°42' E, alt. cca. 1310 m.s.m., 26.X.1992, leg. C. & K. Vánky. Holotypus in Herbario Ustil. Vánky, HUV 15761, isotypi in Vánky, Ust. exs. no. 917 (ut *Sporisorium arundinellae*).

Sori in spiculis omnibus eiusdem inflorescentiae, globoidei usque ellipsoidales, saepe cum apicibus acutis indumentorum floralium internorum partim destructorum, 0,5–0,8 x 0,6–1,2 mm, partim glumis obtecti, primum peridio crasso origine plantae nutrientis et fungali cooperti, quo ab apice eius rupto massam atrobrunneam, semiagglutinatam usque pulveream glomerulorum sporarum laxorum, sporarum et cellularum sterilium columellam centralem obtusam, tenuiescentem, ramulis apicalibus brevibus instructam circumdantem ostendentes. *Glomeruli sporarum* ephemeri. *Sporae* in maturitate singulae, subglobosae, ellipsoidales usque subpolyedrice parum irregulares, 8–11 x 9,5–14,5 µm, mediocriter atro-flavidobrunneae; pariete aequali, 0,5–1 µm crasso, subtiliter, dense punctatoverruculoso usque verruculoso-echinulato; imago obliqua sporarum levis usque leniter serrulata. *Cellulae steriles* in catervis parvis vel in catenis brevibus, cellulae singulae irregulares, lateribus uno vel pluribus deplanatis, 4–9,5 x 6,5–12 µm, subhyalinae vel colore flavidobrunneo tinctae; pariete aequali, cca. 0,5 µm crasso, levi. *Germinatio sporarum* cum hyphis ramificatis.

Sori (Fig. 49) in all spikelets of an inflorescence, globoid to ellipsoidal, often with acute tips of partly destroyed inner floral envelopes, 0.5–0.8 x 0.6–1.2 mm, partly hidden by the glumes, at first covered by a thick peridium of host and fungal origin which ruptures from its apex disclosing the dark brown, semi-agglutinated to powdery mass of loose spore balls, spores and sterile cells surrounding a stout, narrowing central columella with short apical branches. *Spore balls* ephemeral. *Spores* (Figs. 43, 44) when mature single, subglobose, ellipsoidal to subpolyhedrally slightly irregular, 8–11 x 9.5–14.5 µm, medium dark yellowish-brown; wall even, 0.5–1 µm thick, finely, densely punctate-verruculose to verruculose-echinulate, spore profile smooth to finely serrulate. *Sterile cells* (Fig. 43) in small groups or short chains, single cells irregular with one or several flattened sides, 4–9.5 x 6.5–12 µm, subhyaline or with yellowish-brown tint; wall even, c. 0.5 µm thick, smooth. *Spore germination* (Fig. 45; on water-agar, in 5 days, at room temp.) results in ramified hyphae.

On *Arundinella pumila* (Hochst.) Steud.; S. Asia (India). Known only from the type collection.

7. ***Tilletia arundinellae*** L. Ling, 1945:1.

Type on *Arundinella anomala* Steud., China, Szechwan Prov., Chengtu, coll. L. Ling, BPI 196372!

Sori in the ovaries, scattered in the inflorescence, inconspicuous, protruding between the glumes, ovoid to horn-shaped, 1–1.5 x 3–4 mm, enclosed by a firm, purplish-tinged peridium which ruptures irregularly revealing a black, pulverulent spore mass intermixed with sterile cells. *Spores* globose or subglobose, rarely broadly ellipsoidal, 21–32(–34) x 22–33(–37) µm, reddish- to blackish-brown, rarely with a papilla or a shorter or longer, sometimes coiled, hyaline appendage; wall 4–5.5 µm thick including the thin (c. 0.8 µm), uniform endospore and the exospore provided with 1.5–3 µm high warts. In SEM the warts are confluent forming shorter or longer, parallel or spirally arranged rows. *Sterile cells* smaller than the spores, 13–20 µm long, hyaline, often pedicelled; wall 1–2.5 µm thick, smooth, collapsed in old specimens.

On *Arundinella anomala* Steud.; E. Asia (China). Known only from the type collection.

8. *Tilletia lineata* R.G. Shivas & Vánky, in Vánky & Shivas, 2001:169. Type on *Arundinella nepalensis* Trin., Australia, Western Australia, Kimberley region, at the Lake Kununurra, 15°46' S, 128°44' E, alt. 20 m, 28.II.1995, leg. A.A. Mitchell, PERTH 3801454; isotype HUV 17450!

For description and illustrations see Vánky & Shivas, 2001:169.

On *Arundinella nepalensis* Trin.; Australia.

T. lineata differs from *T. arundinellae* by smaller spores (20–27(–30) µm long), warts which are not fusing into rows, seen in SEM, and by larger sterile cells (20–40 µm long).

Excluded or synonyms are:

Sorosporium arundinellae H. & P. Sydow, 1901:(2), (type on *Arundinella anomala* Steud. (= *A. hirta* (Thunb.) C. Tanaka), Japan, Saitama Pref., Omiya city, 20.XI.1899, Nishida & Nambu, BPI 179450! & 195110!) is ***Ustilaginoidea arundinellae*** Henn., an anamorphic Ascomycete (comp. also Ling, 1951:106 & 1953c:344).

Ustilago arundinellae-hirtae S. Ito, 1935:88, type on *Arundinella hirta* (Thunb.) C. Tanaka var. *ciliata* Koidz., Japan, was considered by Kakishima (1982:85) to be a synonym of *Ustilago kusanoi* = ***Sporisorium kusanoi*** (Syd. & P. Syd.) Vánky, type on *Miscanthus sacchariflorus* Hackel, tribe Andropogoneae, subtribe Saccharinae, Japan. Indeed, the two types are identical in their sori and spore morphology and indistinguishable from each other. I suspect that the host plant of *U. arundinellae-hirtae* is a *Miscanthus* sp., which was not possible to verify on the specimens at hand (see also Vánky, 2000b:156).

Ustilago pimprina Thirum. & Pavgi is ***U. egenula*** Syd., P. Syd. & Butler. *Ustilago pimprina* Thirumalachar & Pavgi (1968/1969:251) was described on "*Arundinella* sp." from India, Poona, at Pimpri, X.1955, M.J. Thirumalachar 1252. It is not known where the type is deposited. Despite the statement in the introduction, it is not in HCIO, IMI or in BPI.

An excellent drawing of the diseased plant in Thirumalachar & Pavgi, 1968/1969, Pl. XV, figs 16 & 17, shows that the host plant is an *Eragrostis,* not *Arundinella*. The description of *Ustilago pimprina* fit well with the characters of *Ustilago egenula* Syd., P. Syd. & Butler (type on *Eragrostis nutans* (Retz.) Nees ex Steud., India). Consequently, I am considering *U. pimprina* to be *U. egenula* (syn. nov.).

Ustilago shimadae Sawada ex L. Ling, Mycologia 41:260, 1949b. — *Ustilago shimadae* Sawada, 1944:34 (invalid name, no Latin diagnosis). — Type on ?*Andropogon* or ?*Arundinella,* Taiwan, Taipeh, 3.IV.1911, Y. Shimada.

It is not known where the type is deposited (Kakishima, in litt.). According to Ling (1949:260), "the *sori* entirely destroy the floral axis, transforming it into a long, curved, flagelliform structure, covered by a whitish, delicate membrane of host tissue, approximately 25 cm long. *Spores* chiefly globose to subglobose, 4.4–6.5 µm diam., smooth, light olivaceous brown". A comparison of *U. shimadae* with *Sporisorium kusanoi* (Syd. & P. Syd.) Vánky (type on *Miscanthus sacchariflorus* Hack., Japan), for which the description fits well with that of *U. shimadae,* may reveal a conspecificity.

Key to the smut fungi of *Arundinella*

1. Sori in the leaves as lead-coloured spots or stripes 2
– Sori elsewhere 3
2. Sori long linear. Spores 7–11 µm long, regular, wall 0.8–1.5 µm thick .... **"*Melanotaenium*" *arundinellae***
– Sori as wide spots. Spores 9–16 µm long, irregular, wall 1–5 µm thick .... **"*Melanotaenium*" *tuberculatae***
3. Spores large, over 20 µm long 4
– Spores smaller 5
4. Spores 22–37 µm long. In SEM warts often confluent in rows. Sterile cells 13–20 µm long .... ***Tilletia arundinellae***
– Spores 20–30 µm long. In SEM warts not confluent in rows. Sterile cells 20–40 µm long .... ***Tilletia lineata***
5. Sori on the stems 6
– Sori in the ovaries 7
6. Spores external around a long, flagelliform columella ...... ***Spor. kusanoi***(?)
– Spores hidden within a tubular sorus .... ***Macalpinomyces effusus***
7. Sori 0.6–1.2 mm long. Spores 9.5–14.5 µm long .... ***Sporisorium arundinellae-pumilae***
– Sori 2–3 mm long. Spores 6.5–10.5 µm long 8
8. Spore balls rather permanent. Spores subpolyhedral or polyhedral, dimorphic .... ***Sporisorium arundinellae-nepalensis***
– Spore balls ephemeral. Spores mostly globose, not dimorphic .... ***Sporisorium arundinellae***

The smut fungi on *Ischaemum* (Poaceae)

Ischaemum L., with c. 65 species throughout the tropics, but mainly in Asia, belongs to the subfamily Panicoideae, tribe Andropogoneae, subtribe Ischaeminae. The genus is often quite difficult to distinguish from *Andropogon* (Clayton & Renvoize, 1986:345). Eleven (+1?) smut fungi could be recognised on *Ischaemum*. The followings have been found to be synonyms: *Sorosporium geminellum* Syd., P. Syd. & Butler is *Sporisorium flagellatum* (Syd., P. Syd. & Butler) Vánky, *Sorosporium yoshinagae* Zundel, and *Ustilago concelata* Zundel represent *Sporisorium ischaemi-anthephoroides* (S. Ito) Vánky & Kakish.

1. *Jamesdicksonia ischaemiana* (Thirum. & Pavgi) R. Bauer, Begerow, A. Nagler & Oberwinkler, 2001:422.

Melanotaenium ischaemianum Thirumalachar & Pavgi, 1967(1968):25. — Type on *Ischaemum semisagittatum* Roxb., India, Poona, Khandala, 14.XI.1954, M.J. Thirumalachar 1242. Topotype on 19.X.1995, N.D. Sharma, C. & K. Vánky, HUV 17524!

Sori on the leaves forming black, ellipsoidal, nonerumpent spots, 1–5 x 1.5–8 mm, or larger by confluence, with spores embedded in the host tissue. *Spores* usually irregularly subpolyhedral, rarely ovoid, (8–)9–13(–15) x (9–)10–18 µm, dark olive-brown; wall irregularly thick, 1–5(–8) µm. *Spore germination* results in holobasidia. On the top of basidia, slightly bent, short ballisto-basidiospores are produced on sterigmata. Basidiospores germinate either by hyphae or give rise to secondary ballistosporidia on sterigmata (Bauer et al., 2001:419, fig. 11).

On *Ischaemum indicum* (Houtt.) Merrill, *I. semisagittatum* Roxb.; Asia (India).

2. *Phragmotaenium indicum* (Vánky, M.S. Patil & N.D. Sharma) R. Bauer, Begerow, A. Nagler & Oberwinkler, 2001:423.

Melanotaenium indicum Vánky, M.S. Patil & N.D. Sharma, in Vánky, 1997b:149. — Type on *Ischaemum indicum* (Houtt.) Merrill, India, Maharashtra State, Kolhapur, Shivaji University Campus, alt. 650 m, 24.X.1995, K. Vánky, HUV 17508!; isotype in HCIO. Paratype on *Ischaemum indicum,* India, Madhya Pradesh, Jabalpur, J.N. Agricultural University Campus, alt. c. 410 m, 27.X.1996, leg. N.D. Sharma, HCIO, HUV 18022!; isoparatypes in Vánky, Ust. exs. no. 1012.

Sori on the leaves forming small, elongated, nonerumpent, black spots, 0.2–0.5 x 0.3–1 mm, or larger by confluence. *Spores* embedded in the host tissue, subglobose, ovoid, broadly ellipsoidal to slightly irregular, 7–11 x 8–13 µm, olive-brown; wall 1–2.5(–3) µm thick, two-layered, slightly uneven, in LM smooth, in SEM finely, densely verruculose. *Spore germination* results in 4-celled phragmobasidia measuring 2–3 x 50–90 µm. On the basidia, laterally, on 1.5–3.5 µm long sterigmata, slightly bent ballisto basidiospores are produced measuring 1.5–2 x 8–11 µm. Basidiospores germinate by hyphae (comp. also Bauer et al., 2001:419, fig. 12).

On *Ischaemum indicum* (Houtt.) Merrill; S. Asia (India).

3. *Sporisorium flagellatum* (Syd., P. Syd. & Butler) Vánky, 1997a:139.

Sorosporium flagellatum H. & P. Sydow & Butler, 1907:489. — Type on *Ischaemum timorense* Kunth, India, Wynaad, Malabar, 30.IX.1904, E.J. Butler 727, HCIO 727; isotypes in Syd. Ust. no. 393, HUV 1667!

Ustilago burmanica H. & P. Sydow & Butler, 1912:250. — Type on *Ischaemum* sp. (= *I. timorense* Kunth), Burma, Moulmein, Kya-in, 9.I.1908, E.J. Butler 1424, HCIO1424; isotypes BPI 159458, 159459, 188925, CONN, HUV 15418! (syn. by Ling, 1949:132, confirmed).

Sorosporium geminellum H. & P. Sydow & Butler, 1912:253. — Type on *Andropogon* sp. (?= *Ischaemum* sp.), India, Assam, Khasia Hills, Maoryngkneng, 12.VI.1911, I.H. Burkill, HCIO 1439; isotype HUV 17284! (syn. nov.).

Sori destroying the whole inflorescence, covered by a yellowish-brown peridium and hidden by the terminal leaf sheath from which a long (up to 5 cm or longer), twisted, flagelliform columella protrudes. At maturity the peridium ruptures, disclosing the blackish-brown, granular-powdery mass of spore balls intermixed with groups of sterile cells. *Spore balls* subglobose to ovoid, 25–50 x 28–65 µm, dark reddish-brown, composed of 7–30 (or more?), rather easily separating spores. *Spores* subglobose, ellipsoidal to irregular with somewhat flattened contact sides, 9–15(–17) x 12–19 µm, reddish-brown; wall 1–1.5 µm thick, in most of the spores with a thinner area, densely and finely verruculose-echinulate which just affects the spore profile. *Sterile cells* in irregular groups, collapsed in old specimens, single cells c. 10–16 µm long, hyaline, thin-walled (c. 0.5 µm), smooth.

On *Ischaemum indicum* (Houtt.) Merrill (*I. ciliare* Retz.), *I. timorense* Kunth (*Spodiopogon blumii* Nees ex Steud.; *S. bryonis* Trin.), *Ischaemum* sp.; S. & E. Asia (Burma, India, Japan, Sri Lanka).

Report of *Ustilago burmanica* on *Ischaemum spathiflorum* Hooker fil. (= *Triplopogon ramosissimum* (Hack.) Bor), from India, Bombay (Kulkarni, ap. Butler & Bisby, 1931:48), refers certainly to *Sporisorium triplopogonis* Vánky.

4. *Sporisorium furcatum* (Syd., P. Syd. & Butler) Vánky, **comb. nov.** Basionym: *Sorosporium furcatum* H. & P. Sydow & Butler, Ann. Mycol. 10:254, 1912. — Type on *Ischaemum aristatum* L., India, Maharashtra State, Nagpur Distr., Lendru, 2.X.1908, P.A. Pandit, HCIO 1442; isotype BPI 195113!

Sori in the inflorescence, 7–15 mm long, partly hidden by the distal leaf sheath, first covered by a thick, brown peridium which ruptures irregularly disclosing the dark brown, semi-agglutinated to powdery mass of spore balls, spores and groups of sterile cells surrounding a central columella composed of several, filiform, agglutinated branches. *Spore balls* variable in shape and size, subglobose, ovoid, elongated or irregular, 40–80 x 40–100(–120) µm, dark reddish-brown to subopaque, composed of tens to hundreds(?) of spores which separate by pressure. *Spores* globose, subglobose, ovoid, ellipsoidal to slightly irregular, subpolyhedral, 7–11.5 x 8–12.5(–14) µm, yellowish-brown; wall even or nearly so, 0.5–0.8 µm thick, densely punctate to finely, densely verruculose-echinulate on the free surface, spore profile smooth, wavy to very finely serrulate. *Sterile cells* in irregular groups, subhyaline to pale yellowish-brown, single cells about the size of the spores, 8–12 µm long, collapsed in old specimens.

On *Ischaemum aristatum* L.; N. Africa (Sudan), S. Asia (India).

5. ***Sporisorium hainanae*** (Zundel) L. Guo, 1998:1.

Sphacelotheca hainanae Zundel, 1939:585. — *Sphacelotheca tonglinensis* (Tracy & Earle) Zundel var. *hainanae* (Zundel) L. Ling, 1953c:334. — Type on *Ischaemum rugosum* Salisb., China, Island of Hainan, Kachek, 13.X.1912, A.S. Hitchcock 19610, BPI 195080!

Sori in all ovaries of an inflorescence, ellipsoidal, 0.5–1.5 x 2–4 mm, more or less hidden by the floral envelopes, at first covered by a light brown peridium which ruptures irregularly revealing a dark brown, powdery mass of spores and sterile cells surrounding a simple, central columella, often with shorter or longer, thin, apical branches. *Spores* when mature single, globose, subglobose to broadly ellipsoidal, 6.5–9 x 7–11 µm, yellowish-brown; wall even, c. 0.5 µm thick, moderately densely, low echinulate, spore profile wavy to finely serrulate. *Sterile cells* in irregular groups, single cells subglobose, ellipsoidal, usually rounded irregular with one or several slightly flattened sides, 8–16 µm long, subhyaline to pale yellowish-brown tinted, collapsed in old specimens; wall 0.5–1.5 µm thick, smooth.

On *Ischaemum aristatum* L., *I. mangaloricum* (Hack.) Stapf ex C.E.C. Fischer, *I. rugosum* Salisb.; E. & S. Asia (China, India, Vietnem), E. Malaysia (Sarawak).

6. ***Sporisorium ischaemi*** (L. Ling) Vánky, **comb. nov.**

Basionym: *Sorosporium ischaemi* L. Ling, Sydowia 4:80, 1950. — Type on *Ischaemum rugosum* Salisb., India, Bombay, [Maharashtra State], Poona, Kumta, without date and collector, FH!

Sori destroying all spikelets of an inflorescence, 2–2.5 x 4–6 mm, conspicuously protruding between the spreading, deformed, outermost floral envelopes, first covered by a thick, brown peridium which ruptures irregularly from its apex disclosing the granular-powdery, blackish-brown mass of spore balls and sterile cells surrounding a stout, central, irregular columella with short, apical branches. *Spore balls* subglobose, ovoid, ellipsoidal, elongated to slightly irregular, 40–110 x 50–150 µm, reddish-brown, composed of tens of spores which separate easily by pressure. *Spores* subglobose, ellipsoidal to usually subpolyhedrally slightly angular, 9–12 x 9–13 µm, yellowish-brown; wall even, 0.5–0.8 µm thick, finely, densely verrucose-echinulate, spore profile very finely serrulate. *Sterile cells* few, in irregular, small groups, single cells 6.5–12 µm long, pale yellowish-brown, collapsed in old specimens.

On *Ischaemum rugosum* Salisb.; S. Asia (India).
Sporisorium ischaemi is close to *S. tonglinense* (Tracy & Earle) L. Guo, in which the spore balls are ephemeral, the spores slightly smaller and more prominently echinulate.

7. *Sporisorium ischaemi-anthephoroides* (S. Ito) Vánky & Kakish., **comb. nov.**

Basionym: *Ustilago ischaemi-anthephoroides* S. Ito, Trans. Sapporo Nat. Hist. Soc. 14:88, 1935. — Type on *Ischaemum anthephoroides* Miq., Japan, Honshu, Echigo Prov., Uchino, 13.VIII.1915, S. Ito, SAPA!

Sorosporium yoshinagae Zundel, 1939:589. — Type on "*Panicum repens* L." (= misnamed *Ischaemum* sp., teste K. Vánky), Japan, Trino-mura [= Shikoku I., Kochi Pref.], Tosa, 8.VIII.1922, T. Yoshinaga, BPI 195131! Topotype: 4.VIII.1940, T. Yoshinaga, SAPA! (syn. nov.).

Ustilago concelata Zundel, 1945:372. — *Sporisorium concelatum* (Zundel) M. Piepenbring, 2002:109. — Type on *Ischaemum latifolium* (Sprengel) Kunth, Colombia, Antioquia, Medellin, "La Norma", 1650 m, VII.1942, C. Garcés O., BPI 159676; isotypes in Fungi of Colombia no. 1643, BPI 196342, HUV 16758! (syn. nov.).

Sori surrounding the floral stem, comprising also the inflorescence, sometimes only its proximal part, while groups of intact spikelets may be present on its distal part, flagelliform, 1–2 mm wide, 2.5–9 cm long, at first more or less hidden by leaf sheaths and also covered with a thin, greyish peridium of host origin, which early flakes away and the dark brown, powdery mass of spores and sterile cells are scattered, leaving behind the naked floral axis as a long, stout, narrowing or flagelliform, often bifurcate columella, sometimes with short branches on its distal part. *Spores* when mature single, rounded to ellipsoidal, typically more or less flattened or even impressed on one side, appearing hemiglobose, 4–6.5 x 5–7 µm, yellowish-brown; wall thin, c. 0.5 µm, thinner on the flattened side, apparently smooth to very finely punctate, in SEM finely, sparsely verruculose. *Sterile cells* in irregular groups, short chains or single, larger than the spores, subglobose, ellipsoidal to usually irregular, with one or several flattened sides, 6–13 x 8–18 µm, hyaline to pale yellowish-brown, collapsed in old specimens; wall 0.5–1µm thick, smooth.

On *Ischaemum anthephoroides* Miq., and its var. *eriostachyum* Honda, *I. aristatum* L. var. *glaucum* (Honda) Koyama (*I. crassipes* (Steud.) Thell.), *I. latifolium* (Sprengel) Kunth, *Ischaemum* sp.; E. Asia (Japan), S. America (Colombia).

Ling (1949a:132) considered *Sorosporium yoshinagae* Zundel to be a synonym of *Sorosporium formosanum* (Sawada) Sawada (= *Sporisorium formosanum* (Sawada) Vánky), type on *Panicum repens* L., Taiwan. Indeed, the spore measurements of *S. formosanum* (5–6.5 x 5.5–7 µm) are close to those of *S. ischaemi-anthephoroides*. However, in *S. formosanum* the peridium is thick, there are numerous, filiform columellae, and the spores are sparsely, usually evidently punctate.

In the description of *U. concelata,* Zundel (1945:372) does not mention the presence of a peridium around the sori and the sterile cells between the spores. Zundel also failed to give the spore measurements, and the measurements of the sori should be 2.5–3 cm, not mm as originally given.

8. ***Sporisorium ischaemicola*** (L. Ling) Vánky, **comb. nov.**

Basionym: *Sphacelotheca ischaemicola* L. Ling, Sydowia 3:126, 1949a. — Type on *Ischaemum timorense* Kunth, Singapore, Botanical Garden, 21.I.1948, R.E. Holttum, IMI 38643! Paratype on *Ischaemum digitatum* Brongn. (= *I. polystachyum* Presl), Papua New Guinea, Morobe, 23.I.1939, M.S. Clemens 10265, BPI 178036!

Sori destroying the inner floral organs ("ovaries") of all sessile spikelets of an inflorescence, ellipsoidal, 1–2 x 2–4 mm, more or less hidden by the floral envelopes, first covered by a brownish peridium which ruptures irregularly at maturity, disclosing the dark brown, semi-agglutinated to powdery mass of spores and sterile cells surrounding a stout, simple, tapering columella of the length of the sorus. *Spore balls* present only in early developmental stage of the spores. *Spores* when mature single, globose, subglobose, to ovoid or ellipsoidal, rather variable in size, wall thickness and coarseness of ornamentation (certainly depending on the original position within the spore ball), 9.5–14 x 10.5–15 µm, medium to dark reddish-brown; wall even to uneven, 0.7–2 µm thick, thick-walled spores often with a much thinner part, surface densely, evidently echinulate, spore profile serrulate. *Sterile cells* in irregular groups, single cells subglobose, ellipsoidal to irregular, 6–16 µm long, subhyaline, wall thin, smooth, collapsed in old specimens.

On *Ischaemum barbatum* Retz. (*I. aristatum* L. sensu Hack.), *I. heterotrichum* Hack., *I. indicum* (Houtt.) Merrill, *I. polystachyum* Presl (*I. digitatum* Brongn.), *I. pubescens* Merr., *I. rugosum* Salisb., *I. timorense* Kunth; S. & SE. Asia (India, Vietnam), Malaysia (Sarawak, Singapore), Indonesia (W. Timor), Australasia (Papua New Guinea), Micronesia.

9. ***Sporisorium ischaemi-rugosi*** (J.N. Mishra) Vánky, **comb. nov.**

Basionym: *Sphacelotheca ischaemi-rugosi* J.N. Mishra, Mycologia 48:872, 1956. — Type on *Ischaemum rugosum* Salisb., India, Bihar, Netarhat, 3000 ft, J.N. Mishra, HCIO 25278; isotope in HUV 17286!

Sori destroying the whole inflorescence, c. 1–3 x 15–20 mm, nearly completely enclosed by the uppermost leaf sheaths, first covered by a thick, brown peridium which dehisces irregularly, disclosing the dark brown, semi-agglutinated to powdery mass of loose spore balls, spores and groups of sterile cells, surrounding a stout, c. 0.7 mm wide, uniform columella with shortly bifurcate tip, protruding beyond the sorus. *Spore balls* variable in shape and size, composed of numerous spores which separate very easily. *Spores* subglobose, broadly ellipsoidal to usually subpolyhedrally slightly irregular, 9.5–12 x 11–13.5 µm, yellowish-brown; wall even, 0.8–1 µm thick, densely, evidently echinulate, spore profile finely serrulate. *Sterile cells* in small or large, irregular groups or chains, single cells subglobose, ellipsoidal to slightly irregular, more or less collapsed in old specimens, 10–17 µm long, subhyaline to pale yellowish-brown; wall 0.5–1 µm thick, smooth.

On *Ischaemum rugosum* Salisb.; S. Asia (India).

10. ***Sporisorium tonglinense*** (Tracy & Earle) L. Guo, 1990:85 (as "*tanglinensis*").

Ustilago tonglinensis Tracy & Earle, 1895:175. — *Sphacelotheca tonglinensis* (Tracy & Earle) Zundel, 1944:406. — *Sphacelotheca tonglinensis* (Tracy & Earle) Y. Ling & Chen, 1945:10 (comb. superfl., not Zundel). — Type on *Ischaemum ciliare* Retz. (= *I. indicum* (Houtt.) Merrill), Singapore, Tanglin (as "Tonglin"), I.1893, H.N. Ridley; isotypes BPI 168200, 168202.

Ustilago ischaemi-akoensis Sawada, 1944:33 (invalid name, no Latin diagnosis). — Type on *Ischaemum akoense* Honda, Taiwan, Fêngsan, Kaohsiung, 28.X.1911, Y. Fujikuro. (syn. by Ling, 1949b:263).

Sori in all spikelets of an inflorescence destroying the inner floral organs, ovoid to ellipsoidal, 1–1.5 x 2.5–4 mm, visible between the spreading glumes, first covered by a thick, pale brown peridium which ruptures in several places disclosing the dark brown, semi-agglutinated to powdery mass of spores and groups of sterile cells surrounding a simple, narrowing central columella, sometimes with short apical branches. *Spores* when mature single, globose or subglobose, more rarely broadly ellipsoidal, 9–11 x 9–12 µm, yellowish- to pale reddish-brown; wall even, prominently echinulate, 1–1.5 µm thick, including the spines, spore profile serrate. *Sterile cells* in irregular groups, subhyaline to pale yellow, single cells 6–18 µm long, collapsed in old specimens.

On *Ischaemum akoense* Honda, *I. digitatum* Brongn., *I. indicum* (Houtt.) Merrill (*I. ciliare* Retz.), *I. muticum* L., *I. timorense* Kunth; S. & E. Asia (China, India, Japan, Sri Lanka, Taiwan), Indonesia (Java), New Caledonia.

Ling (1949b:263) corrected the specific epithet *tonglinensis* to *tanglinensis*. I prefer to retain the original spelling (see ICBN 60.3).

11. ***Tilletia ischaemi*** Vánky & N.D. Sharma, 2001:71.

Type on *Ischaemum rugosum* Salisb., India, Madhya Pradesh, Jabalpur, Agricultural University Campus, alt. 410 m, 4.XI.1992, N.D. Sharma, HUV 17453!; isotypes HCIO 43237, BPI.

Sori in some ovaries of an inflorescence, swollen, subcylindrical, 1–1.5 x 4–8 mm, protruding between the floral envelopes, first covered by a thick membrane of host origin (pericarp) which ruptures irregularly disclosing the black, powdery mass of spores intermixed with sterile cells. *Spores* globose, subglobose to broadly ellipsoidal, 17.5–24(–28) x 18–26(–30) µm, dark reddish-brown to almost opaque, provided with densely situated, 1–2(–2.5) µm high conical to flattened warts, in surface view appearing as dark, small polygonal areas. *Sterile cells* subglobose, ovoid, ellipsoidal to slightly irregular, 15–22 x 16–26(–30) µm, light yellowish-brown; wall 1.5–2.5 µm thick, often with two or several layers, smooth.

On *Ischaemum rugosum* Salisb.; S. Asia (India). Known only from the type collection.

? ***Sorosporium semisagittatum*** Thirumalachar & Pavgi, 1967(1968):22. Type on *Ischaemum semisagittatum* Roxb., India, Maharashtra State, Poona, Khandala, 14.XI.1954, M.J. Thirumalachar 1235.

No specimen of *S. semisagittatum* was available for study. The original description is: "*Sori* ovaricolous, infecting only few spikelets in a panicle, forming elongate, greyish-brown fusoid bodies, 1.5–2 x 4–5 mm, half enclosed by the glumes; pinkish false membrane rupturing irregularly at maturity releasing dusty, brownish-black spore mass and a fine, simple columella. *Spore balls* irregular, semipermanent and opaque. *Spores* dark brown, subglobose, mostly polyhedral with depressed surfaces, 9–13.5 µm in diameter. Epispore thick and finely verrucose. Inner sterile cells rather few in number, usually in groups of 6 to 12, hyaline to tinged yellowish, globoid, thin-walled, smooth and measuring 6–10.5 µm in diameter." Furthermore, the authors write: "The smut resembles in some extent *Sorosporium polycarpum* Syd. which is also ovaricolous, developing semi-permanent spore balls on *Ischaemum pectinatum* Trin. in Australia. However, the spores of this are 4–5 to 7 µm in diameter and much smaller than the one under study in which they are 9–13 µm." The flaw of this statement is, on one hand, that the type of *Sorosporium polycarpum* (= *Sporisorium polycarpum* (Syd.) Vánky) is on *Eremochloa muricata* Hack., on the other that *Ischaemum pectinatum* Trin. is not a member of the Australian flora (comp. Simon, 1993).

Key to the smut fungi of *Ischaemum* (*S.* = *Sporisorium*)

1. Sori on the leaves forming blackish spots 2
– Sori elsewhere, not forming blackish spots 3
2. Sori 1–5 mm wide. Spores 9–18 µm long; wall 1–5(–8) µm thick .... ***Jamesdicksonia ischaemiana***
– Sori 0.2–0.5 mm wide. Spores 8–13 µm long; wall 1–2.5(–3) µm thick .... ***Phragmotaenium indicum***
3. Sori in the ovaries or spikelets 4
– Sori in the whole inflorescence 9
4. Spores 18–26(–30) µm long, with 1.5–3 µm high warts...***Tilletia ischaemi***
– Spores smaller 5

5. Sori in some spikelets of an inflorescence. Spore balls semi-permanent .... ***S. semisagittatum***
– Sori in all spikelets of an inflorescence. Spore balls ephemeral 6
6. Spores 8–10 µm long .... ***S. hainanae***
– Spores larger 7
7. Spores 10.5–15 µm long; wall unevenly thick .... ***S. ischaemicola***
– Spores 9–13.5 µm long; wall evenly thick 8
8. Spores prominently echinulate, profile serrate .... ***S. tonglinense***
– Spores finely echinulate, profile very finely serrulate .... ***S. ischaemi***
9(3). Spores 5–7 µm long, flattened on one side, apparently
smooth to very finely punctate .... ***S. ischaemi-anthephoroides***
– Spores larger, not flattened on one side, evidently ornamented 10
10. Columella long, flagelliform. Spores 12–19 µm long .... ***S. flagellatum***
– Columella not so. Spores smaller 11
11. Spore balls 40–120 µm long. Spores 8–12.5(–14) µm long, densely punctate to verruculose-echinulate. Sterile cells 8–12 µm long .... ***S. furcatum***
– Spore balls ephemeral. Spores 11–13.5 µm long, densely,
evidently echinulate. Sterile cells 10–17 µm long .... ***S. ischaemi-rugosi***

A new genus

Many years ago, during my work at the University of Tübingen, I formulated a working hypothesis that species of *Ustilago* are restricted to host plants in the Poaceae. The hypothesis proved fruitful. The revision of "*Ustilago*" species on host plants other than in Poaceae lead, on one hand, to the description of new genera, such as *Bauerago* Vánky (1999) for *Ustilago* species on Cyperaceae and Juncaceae, *Tothiella* Vánky (1999) on Cruciferae (recently transferred into *Thecaphora*), or *Vankya* Ershad (2000) on Liliaceae. On the other hand, it lead to new arrangements, such as the transfer of 55 *Ustilago* species into the genus *Microbotryum* (Vánky, 1998a). Application of modern methods, such as ultrastructural (Bauer, Oberwinkler & Vánky, 1997) and molecular biological (Stoll, 2001) showed also the correctness of the hypothesis.

There is a further "*Ustilago*" species, *U. euphorbiae* Mundkur, on *Euphorbia* (Euphorbiaceae) which certainly does not belong to *Ustilago* or any other known genus (comp. Vánky, 2002b). For it, I am proposing:

Ahmadiago Vánky, **gen. nov.**

Sori on host plants in the Euphorbiaceae. Peridium, columella and sterile cells are lacking. Spore mass powdery. Spores single, pigmented (brown, without violet or orange-yellow tint).

Sori in plantis nutrientibus familiae Euphorbiaceae. Peridium et columella et cellulae steriles nullae. Massa sporarum pulverea. Sporae singulae, pigmentiferae (brunneae, neque colore violaceo, neque aurantiacoflavido tinctae). Typus generis:

Ahmadiago euphorbiae (Mundkur) Vánky, **comb. nov.**
Basionym: *Ustilago euphorbiae* Mundkur, Trans. Brit. Mycol. Soc. 24:331, 1940. — Type on *Euphorbia dracunculoides* Lam., India, Punjab, Kalashakaku, 18.VIII.1936, S. Ahmad, HCIO; isotypes IMI, K, HUV 5475!

Sori in the seeds as ovoid or slightly irregular, c. 2 x 3 mm large bodies filled with dark chocolate-brown, powdery spore masses produced within the tissues of the endosperm, cotyledons and embryo, enclosed by the intact testa. True peridium as well as columella/ae are lacking. *Spores* globose, subglobose, ovoid, broadly ellipsoidal or slightly irregular with a more or less flattened side, 5–7(–8) x 5.5–8(–9) µm, olivaceous brown, paler on the flattened side; wall uneven, 0.7–0.8 µm thick on the darker side, 0.2–0.3 µm thick on the paler side, smooth. *Spore germination* unknown.

On Euphorbiaceae: *Euphorbia dracunculoides* Lam.; S. Asia (India). Known only from the type collection.

Etymology: This genus is named in honour of the excellent botanist, phanerogamist and mycologist, Dr. Sultan Ahmad, an explorer and indefatigable collector of micromycetes of India and West Pakistan, among them a great number of smut fungi, including *Ustilago euphorbiae.* He also described innumerable new microfungi and published, among others, the Ustilaginales of West Pakistan (1956, and several additions).

New names

Sorosporium leersiae and *Sporisorium leersiae* represent the same fungus

Mishra (1956) described *Sorosporium leersiae* on *Leersia hexandra* from India, Bihar. The fungus belongs to the genus *Sporisorium*. The same fungus, on the same host plant, from India, Assam, was also described by Bag & Agarwal (2001) as *Sporisorium leersiae*. Mishra's name has priority, but its recombination into *Sporisorium* creates a later homonym. The proposed name, synonymy and description of this smut fungus are:

Sporisorium leersiae-hexandrae Vánky, **nom. nov.**
Replacing: *Sorosporium leersiae* Mishra, Mycologia 48:876, 1956. — Type on *Leersia hexandra* Swartz, India, Bihar, Ranchi farm, without date, coll. J.N. Mishra (type ubi?).

Sporisorium leersiae Bag & D.K. Agarwal, 2001:221. — Type on *Leersia hexandra*, India, Assam, Johrat, IV.1998, M.K. Bag, HCIO 43170; isotype HUV 20276! (syn. nov.).

Sori destroying the whole inflorescence, enclosed by the uppermost leaf sheath from which only the long, filiform columellae protrude, first covered by a delicate peridium which early ruptures disclosing the black, granular-powdery mass of spore balls and numerous filiform columellae. *Spore balls* variable in shape and size, globose, ellipsoidal, elongated, often slightly bent, 25–65 x 30–100(–110) µm, dark reddish-brown to opaque, composed of numerous spores which separate by pressure. *Spores* rather uniform, globose, subglobose, ellipsoidal to slightly subpolyhedrally irregular, 5–6.5 x

5–7(–8) µm, light yellowish-brown; wall even, c. 0.4 µm thick, finely, sparsely punctate to verruculose, spore profile smooth to finely wavy. *Sterile cells* not seen.

On Poaceae: *Leersia hexandra* Swartz; S. Asia (India).

The type of *Sorosporium leersiae* Mishra was not seen by me. Despite the statement by Mishra, it is not deposited with BPI, HCIO or IMI. However, its description corresponds with the type of *Sporisorium leersiae* Bag & D.K. Agarwal (which is partly damaged by insects; hence the large spore ball measurements in the original description which refer to insect excrements).

Sporisorium perforatum Vánky, **nom. nov.**

Replacing *Sphacelotheca mnesitheae* Mundkur & Thirum., in Thirumalachar & Mundkur, Mycol. Pap. 40:3, 1951 (not *Sporisorium mnesitheae* (Mishra) Vánky, opus praesens). — Type on *Mnesithea laevis* (Retz.) Kunth (*Rottboellia perforata* Roxb.), India, Mysore, Goribidanur, 20.XII.1944, M.J. Thirumalachar, HCIO 10786; isotypes BPI 195100, HUV 17291!

Sori destroying some spikelet-pairs of the racemes of the partially congested, witches' broom like inflorescence, bullate, 1–2 x 2–3 mm, first covered by a thick, brown peridium which ruptures irregularly disclosing the dark brown, semi-agglutinated to powdery mass of spores and sterile cells and a short, conical columella with longitudinal furrows. Distally, a sorus may bear healthy spikelet-pairs but these disarticulate early. *Spores* when mature single, globose, subglobose, ovoid to broadly ellipsoidal, 5.5–7(–8) x 5.5–8(–9) µm, medium reddish-brown; wall even, c. 0.5 µm thick, finely, sparsely punctate-verruculose, spore profile smooth to finely wavy. *Sterile cells* in small, irregular groups, single cells ellipsoidal or slightly irregular, larger than the spores (12–20 µm long), hyaline, collapsed in old specimen; wall 1–1.5 µm thick, smooth.

On Poaceae: *Mnesithea laevis* (Retz.) Kunth (*Rottboellia perforata* Roxb.); S. Asia (India). Known only from the type collection.

Sporisorium shivasii Vánky, **nom. nov.**

Replacing *Ustilago confusa* Massee, in Cooke, Grevillea 20:65, 1892 (not *Sporisorium confusum* (H.S. Jackson) Vánky, 2001:306, on *Aristida* species). — Type on *Panicum paradoxum* R. Br. (= *Pseudoraphis paradoxa* (R. Br.) Pilger), Australia, Victoria, Lake King, II.1855, F. Mueller, Herb. Berkeley 4744, in K.

Sorosporium chamaeraphis Syd., in Sydow & Petrak, 1928:431. — *Sporisorium chamaeraphis* (Syd.) Vánky, 1998b:330. — Syntype on *Chamaeraphis muricata* (L. fil.) Merr. (= *Pseudoraphis spinescens* (R. Br.) Vickery), Philippine Islands, Luzon, Pampanga Prov., Porac, X.1923, M.S. Clemens 4617. (syn. nov.).

For its description see Vánky, 1998b:330 (as *Sporisorium chamaeraphis*).

On Poaceae: *Pseudoraphis brunoniana* Griff., *P. paradoxa* (R. Br.) Pilger, *P. spinescens* (R. Br.) Vickery (*Chamaeraphis spinescens* (R. Br.) Poiret; *C. muricata* (L. fil.) Merrill; *C. aspera* (Koenig) Nees); Australia, Philippines.

By study of the type specimen of *Ustilago confusa,* Dr. R.G. Shivas (BRIP, Brisbane, Australia) demonstrated that the sori are destroying the whole inflorescence (not only the ovaries), that the spore mass and spores have no violet tinge (as stated in the original description), and peridium, columellae and spore balls are present, which are typical for *Sporisorium.* By comparison, it turned out that this fungus is identical with the later described "*Sorosporium*" *chamaeraphis* Syd.

New combinations

Since the paper of Bauer, Oberwinkler & Vánky, 1997, it is known that the dark-spored "*Entyloma*" and "*Melanotaenium*" species of grasses belong to the Georgefischeriales, not to the Entylomatales, as the true *Entyloma* species of dicotyledonous host plants do. Bauer, Begerow, A. Nagler & Oberwinkler (2001), based on spore germination and/or molecular data, demonstrated that these smuts belong to the genera *Jamesdicksonia* (7 spp.), *Eballistra* (3 spp.), or *Phragmotaenium* (1 sp). Unfortunately, for most of these smuts germination and/or molecular data are not known. Therefore, their generic place within the Georgefischeriales remains uncertain (comp. also Vánky, 2002b).

Jamesdicksonia eleocharidis (Sawada ex L. Ling) Vánky, **comb. nov.** Basionym: *Entyloma eleocharidis* Sawada ex L. Ling, Mycologia 41:255, 1949b. — *Ustilago eleocharidis* Sawada, 1943:39 (nomen invalid.; ICBN 36.1). — *Jamesdicksonia eleocharidis* (Sawada) R. Bauer, Begerow, A. Nagler & Oberwinkler, 2001:422, comb. illegit. (based on *Ustilago eleocharidis* Sawada, 1943:39, nomen invalid.). — Type on *Eleocharis dulcis* (Burm. fil.) Trin., Rep. China (Taiwan, Formosa), Taipei, 16.XI.1934, K. Sawada; isotype HUV 12056!

Entyloma eleocharidis Pavgi & R.A. Singh, 1968(1969):425, later homonym. — Type on *Eleocharis plantaginea* R. Br., India, Uttar Pradesh, Varanasi, 5.X.1964, M.S. Pavgi 351 & R.A. Singh; isotype HUV 17386!; isotopotype HUV 15995! (syn. by Vánky, 1996:92).

Sori on the culms as circular to oval spots, 0.1–1.5 mm in diameter, or larger and irregular by confluence, lead-coloured, non-erumpent. *Spores* embedded in the host tissue, subepidermal, agglutinated in rather permanent groups or parallel columns in the intercellular spaces of the mesophyll; single spores subpolyhedrally irregular, rarely subglobose, 7–11 x 9–13(–15) µm, light olivaceous-brown; wall even or slightly uneven, 0.8–1.5 µm thick, smooth. *Spore germination* results in aseptate basidia bearing an apical whorl of 2–6 subcylindrical, hyaline basidiospores measuring 2.2–2.5 x 7.5–20 µm. Basidiospores conjugate in situ giving rise to ellipsoidal or falcate secondary sporidia, 0.7–1.2 x 2.5–7.5 µm (Pavgi & Singh, 1968(1969), 1969, 1970).

On Cyperaceae: *Eleocharis dulcis* (Burm. fil.) Trin. (*E. tuberosa* Schult.), *E. plantaginea* R. Br., *Eleocharis* sp., S. & E. Asia (China, India, Pakistan, Taiwan).

Jamesdicksonia melinidis (Dennis) Vánky, **comb. et stat. nov.**

Basionym: *Melanotaenium majus* (Har. & Pat.) Cif. var. *melinidis* Dennis, Trans. Brit. Mycol. Soc. 90:471, 1988. — Type on *Melinis macrochaeta* Stapf & Hubbard, Nigeria, Vom, 27.XII.1963, R. Wheeler Harris, K.

Sori in the leaves, 0.5–2 x 1–5 mm, lead-coloured, similar to those of *Jamesdicksonia major* (Har. & Pat.) Vánky (type on *Sporobolus spicatus* (Vahl) Kunth, Chad). *Spores* subglobose to ellipsoidal, often polyhedral by mutual pressure, 8–11 x 9–14 µm, brown; wall 1–2 µm thick, smooth.

On Poaceae: *Melinis macrochaeta* Stapf & Hubbard; Africa (Nigeria). Known only from the type locality.

Type not seen. Description partly taken from Dennis, 1988:471.

Macalpinomyces neglectus (Niessl) Vánky, **comb. nov.**

Basionym: *Ustilago neglecta* Niessl, in Rabenhorst, Fungi europaei exs. no. 1200, 1868. — *Sporisorium neglectum* (Niessl) Vánky, 1985a:119. — Type on *Setaria glauca* auct., non (L.) P. Beauv. (= *S. pumila* (Poir.) Roem. & Schult.), Austria, Steiermark, near Graz, coll. G. von Niessl; isotypes in Rbh., Fgi. eur. no. 1200, HUV 4156!

For description and illustrations see Vánky, 1994:203 & 216.

This smut was transferred into the genus *Sporisorium*, based on the presence of groups of thin-walled, hyaline sterile cells between the spores. There is also a peridium around the sori, composed of host and fungal elements and a short columella-like structure in the sori. Because of the lack of spore balls and well-developed columella/ae, several mycologists preferred to retain it in the genus *Ustilago*. During the past ten years, the generic delimitation of *Macalpinomyces* was clarified and 33 species have been described or transferred into this genus. The characters of *Ustilago neglecta* fit also best with the characters of the emended *Macalpinomyces* (Vánky, 2002b:92), hence its transfer into this genus.

Sporisorium andropogonis-tectorum (L. Ling) Vánky, **comb. nov.**

Basionym: *Ustilago andropogonis-tectorum* L. Ling, Sydowia 7:152, 1953a. — Type on *Andropogon tectorum* Schum., Sierra Leone, Hill Station, 27.VII.1941, F.C. Deighton M2302. Holotype IMI 10966; isotype BPI 157098. Paratype on *Andropogon tectorum,* Nigeria, 1936, J. West 69, IMI 44426; HUV 17809!

Sori destroying the whole young floral shoots, transforming each into an elongated, somewhat curved, up to 20 cm long, whip-like structure, first covered by the epidermis which flakes away disclosing the olivaceous-brown, semi-agglutinated to powdery mass of spores intermixed with sterile cells. *Spores* globose, subglobose, often flattened on one side, 7.5–9.5 x 8–10.5(–12) µm, yellowish-brown; wall slightly thinner on one side, 0.4–0.8 µm thick, finely, densely verrucose-echinulate; spore profile wavy to finely serrulate. *Sterile cells* in irregular groups, single cells 8–16 µm long, subhyaline, collapsed in old specimens; wall c. 1 µm thick, smooth.

On Poaceae: *Andropogon tectorum* Schum.; Africa (Nigeria, Sierra Leone).

Sporisorium mnesitheae (Mishra) Vánky, **comb. nov.**

Basionym: *Sorosporium mnesitheae* Mishra, Mycologia 49:257, 1957. — Type on *Mnesithea laevis* (Retz.) Kunth, India, Bihar, Ramgarh, Nayasarai, 15.XI.1955, J.N. Mishra, HCIO; isotypes BPI 180070, IMI 68185, HUV 17363!

Sori in all spikelets of an inflorescence, ellipsoidal, 0.8–1 x 2–3 mm, showing between the spreading glumes, first covered by a pale brown peridium which ruptures from its apex disclosing the black, semi-agglutinated to granular-powdery mass of spore balls surrounding a stout, narrowing central columella, rarely with 1–2 short apical branches. *Spore balls* variable in shape and size, ellipsoidal, ovoid, elongated or irregular, 25–50(–70) x 25–80(–110) µm, dark reddish-brown to subopaque, composed of 10–100? (or more?) spores which separate easily by pressure. *Spores* slightly dimorphic, rounded to subpolyhedrally irregular, rarely globose or ellipsoidal, 7.5–12 x 9.5–13(–14.5) µm, reddish-brown; wall uneven, thickest at the angles, 0.5–1.5 µm thick, densely verrucose, spore profile wavy to finely serrulate. Inner spores lighter in colour, wall thinner, finely densely punctate. *Sterile cells* absent.

On Poaceae: *Mnesithea laevis* (Retz.) Kunth (*Rottboellia perforata* Roxb.); S. Asia (India).

Sporisorium stuhlmannii (Henn.) Vánky, **comb. nov.**

Basionym: *Ustilago stuhlmannii* Hennings, Bot. Jahrb. Syst. 17:3, 1893. — *Sphacelotheca stuhlmannii* (Henn.) Zundel, 1930:136. — Type on *Andropogon* sp., "Central Afrikan. Seengebiet" (Central African Lakes Territory), Ukami, Mrogoro, 18.V.1890, F. Stuhlmann 63, "Emin Pascha Expedition", BPI 198126!

Sori around the inflorescence axis and inflorescence, up to 10 cm long, protruding from the distal leaf sheath, covered by a brown peridium which flakes away disclosing the blackish-brown, semi-agglutinated to powdery mass of spore balls and spores, intermixed with groups of sterile cells, surrounding a stout, central columella with short lateral branches on its distal part. The inflorescence is destroyed but some, partly destroyed or even apparently healthy spikelets may be left intact. *Spore balls* globose, ellipsoidal to elongated or irregular, 40–90 x 50–120 µm, reddish-brown, composed of tens to hundred of spores which separate easily. *Spores* variable in shape and size, rounded, subpolyhedrally irregular, ellipsoidal, rarely elongated or irregular, 8–12 x 9–13.5 µm, yellowish-brown; wall even, c. 0.5 µm thick, finely, densely verruculose-echinulate, spore profile wavy to finely serrulate. *Sterile cells* in irregular groups or chains, single cells 7–13 µm long, subhyaline, collapsed in old specimen; wall even, 0.5–0.8 µm thick, smooth.

On Poaceae: *Andropogon* sp. Known only from two collections in C. and E. Africa, made by F. Stuhlmann.

Sporisorium styppeiochloae (Dennis & M.B. Ellis) Vánky, **comb. nov.** Basionym: *Sorosporium styppeiochloae* Dennis & M.B. Ellis, Kew Bull. 35:846, 1981. — Type on *Styppeiochloa gynoglossa* (Goossens) De Winter, Mozambique, Lourenço Marques, Namaacha (Namahacha), alt. 650 m, 9.XII.1948, Carvalho 300, K; isotype IMI 48001!

Sori in ovaries, ovoid, 0.5–1 x 1.5–2 mm, with an acute tip, partly hidden by the glumes, first covered by a pale brown peridium which ruptures irregularly disclosing the blackish-brown, granular-powdery mass of spore balls. Columella very short. *Spore balls* globose, ovoid, ellipsoidal, elongated to irregular, 12–28 x 15–35(–40) µm, yellowish- to dark reddish-brown, composed of 3–16 (or more?) spores which separate by pressure. *Spores* variable in shape, more or less irregular with one or several flattened sides and rounded free surface, 6–9 x 7–12 µm, yellowish-brown; wall c. 0.5 µm thick, in LM smooth on the contact sides, somewhat thicker on the free surface where provided with small, irregular tubercles, in SEM contact sides very finely verruculose. *Sterile cells* absent.

On Poaceae: *Styppeiochloa gynoglossa* (Goossens) De Winter; SE. Africa (Mozambique). Known only from the type collection.

Tilletia patagonica (Hirschh.) Vánky, **comb. et stat. nov.** Basionym: *Tilletia fusca* Ellis & Everh. var. *patagonica* Hirschhorn, Rev. Mus. La Plata 5:8, 1942. — Type on *Festuca bromoides* L., Argentina, Neuquén, Aluminé, Villa, alt. 1200 m, III.1940, E. Hirschhorn. Holotype in Herb. Hirschhorn 453, isotype LPS 4924.

Sori in all ovaries of an inflorescence, fusiform, 0.5–1 x 2–3.5 mm, showing between the spreading glumes, first covered by the pericarp which ruptures at maturity disclosing the dark brown, powdery mass of spores and sterile cells. *Spores* globose, subglobose, ovoid to ellipsoidal, rarely somewhat irregular, 22.5–28 x 23–32 µm, yellowish-brown, reticulate, 6–11 meshes per spore diameter, muri 1.5–3 µm high, in optical median view appear as acute or subacute spines, interspaces often with a small tubercle.

Sterile cells few, smaller than the spores, up to 18 µm long, subhyaline, collapsed in old specimen.

On Poaceae: *Festuca bromoides* L.; S. America (Argentina). Known only from the type collection.

Tilletia patagonica differs from *T. fusca* (= *T. bromi* (Brockm.) Brockm., sensu lato) in having larger spores, more reticulum per spore diam., higher muri and a tubercle in the interspaces. The spores of *T. bromi* are 20–28 µm long, 6–10 meshes per spore diam., the muri are 1.5 µm high, the interspaces are smooth, without tubercle.

Tranzscheliella amplexa (Syd.) Vánky, **comb. nov.**

Basionym: *Ustilago amplexa* H. Sydow, Ann. Mycol. 22:278, 1924. — Type on *Diplachne fusca* P. Beauv. ex Roem. & Schult., Egypt, Belbes in the delta of Nile River, V.1880, G. Schweinfurth; isotypes Thümen, Mycoth. univ. no. 1818, HUV 3854!

Sori surrounding upper internodes of sterile shoots, 0.2–0.3 x 10–15 cm, partly hidden by leaf sheaths, first covered by a thin, greyish peridium which flakes away disclosing the olivaceous-brown, powdery mass of spores. *Spores* globose, subglobose, rarely ovoid or broadly ellipsoidal, laterally compressed, in side view 4–5 µm wide, in plane view 5.5–6.5(–7) x 6–7(–7.5) µm, medium yellowish-brown; wall even, c. 0.5 µm thick, slightly thinner on the flattened sides, smooth in LM, finely, moderately densely verruculose in SEM.

On Poaceae: *Diplachne fusca* P. Beauv. ex Roem. & Schult.; N. Africa (Egypt).

Tranzscheliella serena (Syd.) Vánky, **comb. nov.**

Basionym: *Ustilago serena* H. Sydow, Ann. Mycol. 35:24, 1937. — Type on *Diplachne fusca* P. Beauv. ex Roem. & Schult., Australia, New South Wales, between Warren and Collie, I.1936, L. Fraser 195; isotypes IMI, HUV 17815!

Sori surrounding the uppermost culms, partly hidden by leaf-sheaths, first covered by a delicate, grey or lead-coloured peridium which flakes away disclosing the olivaceous-brown, powdery mass of spores. *Spores* globose to broadly ellipsoidal, 6.5–8 x 7–10 µm, pale yellowish-brown; wall even, c. 0.5 µm thick, smooth in LM, finely, sparsely verruculose in SEM.

On Poaceae: *Diplachne fusca* P. Beauv. ex Roem. & Schult.; Australia.

T. serena differs from *T. amplexa* especially in the larger, paler spores.

Ustanciosporium eleocharidis (Thirum. & Pavgi) Vánky, **comb. nov.**

Basionym: *Sphacelotheca eleocharidis* Thirumalachar & Pavgi, Sydowia 7:99, 1953. — Type on "*Eleocharis* sp." (= misnamed *Fimbristylis* sp., teste K. Vánky), India, Bihar, Netarhat, 2.IX.1952, M.J. Thirumalachar. Holotype HCIO 20933, isotype HUV 15510!

Sori destroying all or almost all flowers in the inflorescence, replacing them by a chocolate-brown, semi-agglutinated mass of spores, globoid, c. 0.5 mm in diameter or larger by confluence, when young covered by a fungal membrane which flakes away disclosing the agglutinated spore mass with powdery surface. *Spores* variable in shape and size, globose, ovoid, ellipsoidal, elongated or irregular, lacrymiform with an acute tip, 8–12 x 9.5–14.5(–16) µm, yellowish-brown, wall even, 0.7–1 µm thick, evidently and typically verrucose-echinulate, the warts or spines are connected by thin threads, evident especially in SEM, forming dense, irregular, often incomplete meshes.

On Cyperaceae: *Fimbristylis* sp. (as "*Eleocharis* sp."); S. Asia (India). Known only from the type collection.

Synonyms

Tothiella transferred into *Thecaphora*

The new classificatory system of the smut fungi and allied taxa (comp. Bauer, Oberwinkler & Vánky, 1997) opened new, earlier unthought-of perspectives for a better, phylogenetic grouping and rearrangement of these fungi. During the last few decades it became evident that a similar morphology does not always reflect a close relationship. This applies to the morphology of fruiting bodies of mushrooms and also to the morphology of the sori, spore balls, spores, basidia and basidiospores of the smut fungi. Ultrastructural- and molecular biological studies have revealed several cases of convergent evolution. The presence or absence of spore balls not necessarily means a close relationship. For instance, within the Doassansiaceae, ten genera have spore balls, one genus (*Doassinga*) has single spores. Within the genera *Schizonella, Orphanomyces* and *Ustanciosporium* there are species with spore balls and others with single spores (comp. also Vánky, 2002b).

I proposed (Vánky, 1999:39) the unispecific genus *Tothiella* Vánky (type *T. thlaspeos* (Beck) Vánky), with single, brown spores in the seeds of Cruciferae. It was separated from the genus *Ustilago* mainly because of the dicotyledonous host plants and its spore morphology. Despite many common characters, *Tothiella* was not included in the genus *Sorosporium* F. Rudolphi (= *Thecaphora* Fingerh.), especially because it has single spores. Based on its ultrastructural characters, *Tothiella* was placed into the Glomosporiaceae, beside *Glomosporium* and *Thecaphora* (including *Sorosporium*), two genera characterised by the presence of spore balls. However, based on a thorough comparative morphological study of the spores, and on what I now regard as the significance of spore balls, I consider it better to place *Tothiella thlaspeos* into the genus *Thecaphora,* reducing *Tothiella* to a synonym of *Thecaphora.*

Thecaphora thlaspeos (Beck) Vánky, **comb. nov.**

Basionym: *Tilletia thlaspeos* Beck, Verh. K. K. Zool.-Bot. Ges. Wien 35:362, 1886. — *Ustilago thlaspeos* (Beck) Lagerheim, in Sydow, Ust. No. 118, 1897. — *Bauhinus thlaspeos* (Beck) Denchev, 1997:424. — *Tothiella thlaspeos* (Beck) Vánky, 1999:39. — Type on *Thlaspi alpestre* L., Austria, Burgenland, near Redlschlag [Újvörösvágás], coll. V. Borbás, HUV 4776!

For taxonomic synonyms, such as *Ustilago seminum* Juel, *U. arabidis-alpinae* Liro, *U. cardamines* Liro, description and illustration of this species, see Vánky, 1999:39-43 (as *Tothiella thlaspeos*).

On Brassicaceae: *Alyssum reiseri* Vel., *Arabis alpina* L., *Ar. corymbiflora* Vest., *Ar. hirsuta* (L.) Scop., *Ar. sagittata* (Bertol.) DC., *Cardamine bellidifolia* L., *Cardaminopsis petraea* (L.) Hiitonen, *Draba aizoides* L., *D. alpina* L., *D. incana* L., *Erysimum diffusum* Ehrh., *E. weltschewii* Urum., *Thlaspi alpestre* L., *T. alpinum* Crantz; Europe.

Aurantiosporium colombianum is immature *A. subnitens*

Piepenbring, 2002:105, described *Aurantiosporium colombianum* M. Piepenbr. because it "differs from *A. subnitens* by larger spores in larger balls and by thicker and lighter coloured spore wall layer". These are typical characters of young, immature spores, known in several genera of smut fungi. Indeed, both sori of the isotype (BPI 840957) are hard and immature, without powdery mass of mature spores. The larger size of the spores of *A. colombianum* ("16–20(–22) µm long") is a result of the thicker exospore ("1–4(–5) µm"). In *A. subnitens* the spores are "(10–)13–17(–19) µm" long, and the spore wall is "ca. 2 µm thick" (Piepenbring, Vánky & Oberwinkler, 1996:63). Measurements of the length of the spores, without exospore, resulted in 12–16(–17.5) µm for both types of these two species.

Obviously, *A. colombianum* was described on a meagre, old collection, preserved in a phanerogam herbarium (BM 598728), on *Scleria lagoensis* Boeck., Colombia, Magdalena Div., Santa Marta, 1898–1899, leg. Smith 237 (holotype COL, isotype BPI). The sori of *A. colombianum* are typical and identical with those of *A. subnitens* (J. Schröt. & Henn.) M. Piepenbr., Vánky & Oberw., known on *Scleria melaleuca* Reichenb. ex Schltdl. & Cam. (lectotype HBG). *A. subnitens* is widely distributed in Central- and South America (Brazil, Colombia, Costa Rica, Panama, Venezuela, and certainly also in other countries). The two host plants, *Scleria melaleuca* and *S. lagoensis* are also "fairly closely related, both belonging to sect. Scleria (Euscleria)" (K. Lye, in litt.).

Consequently, I consider *Aurantiosporium colombianum* M. Piepenbr. to be a synonym of *A. subnitens* (J. Schröt. & Henn.) M. Piepenbr., Vánky & Oberw. (syn. nov.).

Farysia ugandana* is *F. butleri

Farysia ugandana Zundel, 1944:403, was described on *Carex spicato-paniculata* C.B. Clarke (as "*paniculata-spicata*"), Uganda, between Kinanira and Kisola, 3.IV.1927, D.H. Linder, BPI 170312!; isotype BPI 170313! Study of the type specimen showed that it is identical with, and a synonym of *Farysia butleri* (Syd. & P. Syd.) H. & P. Sydow, 1919:42. — Type on "*Scleria elata* Thw." (= misnamed *Carex filicina* Nees, teste K. Vánky). (syn. nov.).

For its description and illustration see Vánky, 2002b:62-63.

On Cyperaceae: *Carex* (subgenus *Indocarex*) spp., *C. condensata* Nees, *C. cruciata* Wahlenb., *C. echinochloae* Kunze, *C. filicina* Nees, *C. indica* L., *C. myosurus* Nees, *C. pyramidalis* Kük., *C. rafflesiana* Boott, *C. spicato-paniculata* C.B. Clarke, and probably other *Carex* species; Africa, SE. Asia, Indonesia, Philippines, Australasia.

The sori and spores of *Farysia ugandana* correspond with those of the type specimen of *F. butleri*. However, a part of one of the two sori of the isotype is much darker and somewhat agglutinated. The spores of this part are dark reddish-brown and almost smooth to finely punctate. The reason for this anomaly is unknown (genetic mutation?). Zundel's description does not refer to these spores.

Sorosporium aeluropodis* is *Ustilago aeluropodis

Ahmad (1956:10) described *Sorosporium aeluropodis* as having spore balls of 40–100 µm in diameter. Study of the type showed that these spore balls are artefacts, produced by insects (excrements). The sori and the spores are typical for *Ustilago aeluropodis*. Consequently, the name and synonyms of this fungus are:

Ustilago aeluropodis (Trotter) Vánky, 1985b:11.

Sphacelotheca aeluropodis Trotter, in Saccardo & Trotter, 1913:413 (as "*aeluropi*"). — *Crozalsiella aeluropodis* (Trotter) Maire, 1917:141 (as "*aeluropidis*"). — Type on *Aeluropus repens* (Desf.) Parl. (= *A. lagopoides* (L.) Trin. ex Thwaites), Libya, Misratha (Misurata), Bu Sceifa, in "sebkha", 15.IV.1913, A. Trotter.

Sorosporium aeluropodis Ahmad, 1956:10 (as *aeluropidis*). — Type on *Aeluropus lagopoides*, Pakistan, Karachi, 28.XII.1951, S. Ahmad 7000, IMI 57438! (syn. nov.).

For description and illustration see Vánky, 1994:348 & 387 (as *Ustilago* "*aeluropi*").

On Poaceae: *Aeluropus laevis* Trin., *A. lagopoides* (L.) Trin. ex Thwaites (*A. repens* (Desf.) Parl.; *A. villosus* Trin.), *A. littoralis* (Gouan) Parl.; SE. Europe (Romania), N. Africa (Algeria, Libya), C. & S. Asia (Azerbajdzhan, Iran, Kazakhstan, Pakistan, Russia, Turkmenia).

Sporisorium agropyri* is *Ustilago cynodontis

Sporisorium agropyri Bag & D.K. Agarwal (2001:219) was described on "*Agropyron strigosum* L." from India, W. Bengal, Kalimpong, IV.1999, coll. M.K. Bag, holotype HCIO 43167, isotype HUV 20277! The good intention of the young mycologist, to collect also healthy plants along with infected ones caused a mistake because the healthy plants do not belong to the smutted ones. Namely, the infected inflorescence of the isotype has remnants of several, thin, digitate, floral branches at the apex of the stem, covered by agglutinated spore mass, mixed with saprophytic fungi. Study of the spores solved the problem. These are unique and typical for *Ustilago cynodontis* (Henn.) Henn. (globose to subglobose, 6.5–8 x 6.5–8.5 µm, laterally flattened, (4.5–)5–6.5 µm wide, smooth in LM, with a small, lighter spot in the middle of the flattened sides, the place where the young spores were connected). The spores of the isotype of *S. agropyri* are partly agglutinated into irregular groups ("spore balls") because the sorus is rather young, and because of the presence of numerous filaments of saprophytic fungi. The "peridium" and "sterile cells", mentioned in the original description of *S. agropyri*, are certainly these saprophytic fungi. Regarding the host plant, of the four *Cynodon* species from the Indian subcontinent, enumerated by Bor (1960:468-471), only *Cynodon dactylon* (L.) Pers. occurs in W. Bengal (and maybe also the introduced *C. plectostachyus* (K. Schum.) Pilger, but this has inflorescences of several whorls of spikes in contrast to the digitate spikes in *C. dactylon*). Consequently, I consider *Sporisorium agropyri* to be *Ustilago cynodontis* on *Cynodon dactylon* (syn. nov.).

Sporisorium martinii* is *Sporisorium lanigeri

I revised the smut fungi of the grass genus *Cymbopogon* (Vánky, 2003b:20-32) and recognised 13 species. Recently, I obtained from Dr. D.K. Agarwal (HCIO, New Delhi, India) a fragment of the type specimen of *Sporisorium martinii* Bag & D.K. Agarwal, 2001:221 (as "*martinae*"). Type on *Cymbopogon martinii* (Roxb.) Watson, India, W. Bengal, Cooch Behar, III.1996, D.K. Agarwal, HCIO 42945, isotype HUV 20273! The specimen turned out to be *Sporisorium lanigeri* (Magnus) Vánky (type on *Cymbopogon schoenanthus*), on a new host plant (host identity not checked by me). *S. lanigeri* is known from Africa, S. Asia and Australia on at least 14 *Cymbopogon* species, and it has been repeatedly "discovered", having 13! taxonomic synonyms (syn. nov.).

Tilletia durangenis* is a synonym of *T. baldratii

Revising the *Tilletia* species of *Eragrostis,* it turned out that *T. durangenis* Durán is identical with and a synonym of the earlier *T. baldratii* Montemart.

Tilletia baldratii Montemartini, 1934:44.
Type on *Poa abyssinica* Jacq. (= *Eragrostis tef* (Zucc.) Trotter), Africa, Eritrea, Tigrai [Tegre] Prov., comm. I. Baldrati. It is not known where the type is deposited. It is not in FT or FI (C. Nepi, in litt.).

Tilletia durangenis Durán, 1970:1101. — Type on *Eragrostis mexicana* (Hornem.) Link, Mexico, Durango, 71.2 mi N.W. of J. G. Aguilera off Hwy. Mex. No. 39, alt. 2286 m, 21.X.1969, R. Durán, WSP 58554; isotype HUV 14446! Paratype WSP 58555, isoparatype HUV 14447 (syn. nov.).

Sori in the ovaries, globoid to usually ellipsoidal, 0.5–0.8 x 0.5–1 mm, dark brown, more or less hidden by the floral envelopes and covered by the fragile pericarp which ruptures irregularly disclosing the semi-agglutinated to powdery, dark brown, foetid mass of spores intermixed with sterile cells. *Spores* globose, subglobose to ellipsoidal, 17–22 x 18–24 µm (including muri but excluding the 1–5.5 µm thick hyaline sheath), yellow to pale yellowish-brown, reticulate, 3–5 meshes per spore diameter, meshes penta- or hexagonal, (2.5–)4–6(–8) µm in diameter, muri in optical median view thin, acute, 0.5–3 µm high. *Sterile cells* globose or ellipsoidal, 8–16 µm long, including the 1–4 µm thick smooth to weakly reticulate wall, but excluding the 4–9.5 µm thick hyaline sheath, content granular.

On Poaceae: *Eragrostis mexicana* (Hornem.) Link, and *E. tef* (Zucc.) Trotter (*Poa abyssinica* Jacq.); Africa (Ethiopia), N. America (USA, Mex.).

The Ethiopian specimen I have seen has somewhat lower muri (0.5–1.5 µm) than the Mexican one (1.5–3 µm) and a thinner hyaline sheath around the spores. In other respects the African and North American specimens are identical.

Ustilago amadelpha is identical with the later *U. scitaminea*, and the consequences thereof

Ustilago amadelpha H. & P. Sydow & Butler, 1912:249, was described on "*Andropogon* sp." from India, Bengal, Muzaffarpur District, Awapur, 15.IV.1911, E.J. Butler 1425, HCIO 1425; isotype HUV 16373! Regarding its host plant, Mundkur (1939:104) wrote: "A note accompanying the specimen states that the grass had no flowers and might be a species of *Saccharum*." Indeed, comparison of the type of *U. amadelpha* with the smut fungi of *Saccharum* (comp. Vánky, 2000b), showed that it is identical with the sugarcane smut, *Ustilago scitaminea* H. Sydow (1924:281), lectotype (design. by Vánky, 1991:492) on *Saccharum officinarum* L., India, Bengal, Bhagalpur, 26.VIII.1907, J.E. Butler, HUV 4454!; isolectotypes in Sydow, Ust. no. 384. *U. scitaminea* is known on *Imperata cylindrica* (L.) Raeuschel, *Miscanthus anomalus* Steud., *M. sacchariflorus* (Maxim.) Hack., *Saccharum barberi* Jeswiet, *S. giganteum* (Walt.) Pers. (*Erianthus giganteus* (Walt.) Muhl.; *E. saccharoides* Michaux), *S. officinarum* L., *S. sinense* Roxb., *S. spontaneum* L.

To avoid the change of *U. scitaminea,* the name of the common, cosmopolitan sugarcane smut into *U. amadelpha,* or maybe more correctly into "*Sporisorium amadelphum*", conservation of the name of *U. scitaminea* is proposed.

Ustilago eragrostidis-japonicana and *U. ugandensis* var. *macrospora* are *Macalpinomyces spermophorus*

Study of the type specimen of ***Ustilago eragrostidis-japonicana*** Zundel (1943:165), type on *Eragrostis japonica* Trin., South Africa, Cape Prov., Vryburg Distr., Welgelegen, IV.1925, G.A. Pentz, PREM 20621!, isotypes BPI 160370 & 188933, and that of ***Ustilago ugandensis*** Henn. var. ***macrospora*** Beeli (1922:6), lectotype (designated here) on *Panicum* sp., Congo, Leopoldville Prov., Kisantu, VII.1914, H. Vanderyst 4657, BR 1318, isolectotype BPI 194482!, revealed that they are identical with ***Macalpinomyces spermophorus*** (Berk. & M.A. Curtis ex de Toni) Vánky, 2003c:210, type on *Eragrostis poaeoides* P. Beauv. var. *megastachya* (Link) A. Gray, USA. (syn. nov.).

For description, synonyms and illustration, see Vánky, 1994:376-377, 435, and 2003c:210-212.

On Poaceae: *Bouteloua, Eragrostis* (principal host), *Sporobolus,* and evidently also on *Panicum* sp.; cosmopolitan.

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Literature Cited

Ahmad S. 1956. Ustilaginales of West Pakistan. Mycol. Pap. 64:1-17.

Bag MK, Agarwal DK. 2001. Taxonomic studies on smut fungi from North-Eastern India. Indian Phytopathol. 54:219-225.

Bauer R, Begerow D, Nagler A, Oberwinkler F. 2001. The Georgefischeriales: a phylogenetic hypothesis. Mycol. Res. 105:416-424.

—, Oberwinkler F, Vánky K. 1997. Ultrastructural markers and systematics in smut fungi and allied taxa. Canad. J. Bot. 75:1273-1314.

Beck G. 1886. Zur Pilzflora Niederösterreichs. III. Verh. K. K. Zool.-Bot. Ges. Wien 35:361-376.

Beeli M. 1922. Notes mycologiques. Bull. Jard. Bot. État 8:1-22.

Berkeley MJ. 1853. (*Ustilago vittata* sp. nov.). Gard. Cron. 1853:148.

Bor NL. 1960. The grasses of Burma, Ceylon, India and Pakistan. (Excluding Bambuseae). Pergamon Press, Oxford, London, New York, Paris, 767 pp.

Brefeld O. 1895. Untersuchungen aus dem Gesammtgebiete der Mykologie. XII. Hemibasidii. Brandpilze III. Münster i. W., Commissions-Verlag v. H. Schöningh. IV + 99-236 pp. + Pls. VI-XII.

Butler EJ, Bisby GR. 1931. The fungi of India. Calcutta. XVIII + 1-237.

Ciferri R. 1931. Quinta contribuzione allo studio degli Ustilaginales. Ann. Mycol. 29:1-74.

Clayton WD, Renvoize SA. 1986. Genera graminum. Grasses of the world. Kew Bulletin Additional Series XIII. London, UK, 389 pp.

Clinton GP. 1906. Order Ustilaginales. In North American Flora 7(1):1-82.

Cooke MC. 1892. Australian fungi. Grevillea 20:65.

Denchev CM. 1997. New combinations in *Bauhinus* (Microbotryaceae). Mycotaxon 65:419-426.

Dennis RWG. 1988. *Melanotaenium majus,* an apparently overlooked African smut. Trans. Brit. Mycol. Soc. 90:471-472.

—, Ellis MB. 1981. A new species of *Sorosporium* (Ustilaginales) from Mozambique. Kew Bull. 35:846.

Durán R. 1970. Hosts and distribution records of Mexican smut fungi. Mycologia 62:1094-1105.

—, Fischer GW. 1961. The genus *Tilletia.* Washington State University, 138 pp.

Ershad D. 2000. *Vankya,* a new genus of smut fungi. Rostaniha 1:65-72 (in English) & 151-161 (in Farsi, and Figs. 1-6).

Gandhe RV. 1998. Teliospore germination and nuclear behaviour in *Urocystis hypoxys.* Indian Phytopathol. 51:26-29.

Griffiths DG. 1907. Concerning some West American fungi. Bull. Torrey Bot. Club 34:207-211.

Guo L. 1990. The genera *Sorosporium* and *Sporisorium* in China. Mycosystema 3:67-88.

— 1998. Three new combinations of *Sporisorium* and three smut species new to China. Mycosystema 17:1-3.

Hennings P. 1893. Fungi africani, II. Bot. Jahrb. Syst. 17:1-42.

Hirschhorn E. 1942. Revisión de las especies de *Tilletia* de la Argentina. Revista Mus. La Plata, N. S., Secc. Bot. 5:1-20 + Pls. I-III.

Hopkins JCF. 1938. A preliminary list of Rhodesian fungi. Trans. Rhodesia Sci. Assoc. 35:97-127.

Ito S. 1935. Notae mycologicae Asiae orientalis II. Trans. Sapporo Nat. Hist. Soc. 14:87-96.

Kakishima M. 1982. A taxonomic study on the Ustilaginales in Japan. Mem. Inst. Agr. & For. Univ. Tsukuba 1:1-124.

Ling L. 1945. A contribution to the knowledge of the Ustilaginales in China. Mycol. Pap. 11:1-12.

— 1949a. Taxonomic notes on Asiatic smuts. I. Sydowia 3:123-134.

— 1949b. A second contribution to the knowledge of the Ustilaginales of China. Mycologia 41:252-269.

— 1950. Taxonomic notes on Asiatic smuts. II. Sydowia 4:74-81.

— 1951. Taxonomic notes on the Ustilaginales. Lloydia 14:101-110.

— 1953a. Taxonomic notes on the Ustilaginales. III. Sydowia 7:151-157.

— 1953b. Taxonomic notes on the Ustilaginales. II. Lloydia 16:180-192.

— 1953c. The Ustilaginales of China. Farlowia 4:305-351.

Ling Y, Chen TL. 1945. Notes on some Fukien species of the family Ustilaginaceae. Res. Bull. Inst. Zool. Bot. Fukien Acad. 1:1-26.

Liro JI. 1924. Die Ustilagineen Finnlands I. Ann. Acad. Sci. Fenn., Ser. A, 17(1):1-636.

Maire R. 1917. Champignons nord-africains nouveaux ou peu connus. Bull. Soc. Hist. Nat. Afrique N. 8:134-200.

Melchior H. ed. 1964. Engler's Syllabus der Pflanzenfamilien. II. Band, 666 pp. Gebrüder Bornträger, Berlin.

Mishra JN. 1956. The Ustilaginales of Bihar. II. Five undescribed species. Mycologia 48:872-876.

— 1957. Ustilaginales of Bihar. III. Some new and interesting smuts. Mycologia 49:256-261.

Montemartini L. 1934. Alcune Ustilaginee dell'Eritrea. Boll. Stud. Inform. Reale Giardino Colon. 13(Ser. 3, 7):44-46.

Mundkur BB. 1939. A contribution towards a knowledge of Indian Ustilaginales. Trans. Brit. Mycol. Soc. 23:86-121.

— 1940. A second contribution towards a knowledge of Indian Ustilaginales. Trans. Brit. Mycol. Soc. 24:312-336.

—, Thirumalachar MJ. 1946. Revision of and additions to Indian fungi I. Mycol. Pap. 16:1-27.

Patil MS. 1992. Smuts of Maharashtra. Indian Phytopathol. 45:179-184.

Pavgi MS, Singh RA. 1968(1969). A new cypericolous *Entyloma* species from India. Nova Hedwigia 15:423-426 + Pl. 47.

—, — 1969. Some interesting aberrations in teliospore germination of *Entyloma eleocharidis*. Pathological Microbiol. 34:375-378.

—, — 1970. Teliospore germination, cytology and development of *Entyloma eleocharidis*. Cytologia 35:391-401.

Piepenbring M. 2002. Annotated checklist and key for smut fungi in Colombia. Caldasia 24:103-119.

—, Vánky K, Oberwinkler F. 1996. *Aurantiosporium,* a new genus for *Ustilago subnitens* (Ustilaginales). Pl. Syst. Evol. 199:53-64.

Ramakrishnan TS. 1952. Additions to fungi of Madras. XII. Proc. Indian Acad. Sci. 35:111-115?.

Saccardo PA., Trotter A. 1913. Fungi Tripolitani. Ann. Mycol. 11:409-420.

Sawada K. 1943. Report of fungi in Taiwan. Series 8 (In Japanese). Rep. Dept. Agric. Gov. Res. Inst. Formosa, Report 85:1-130 + Pls. 1-6.

— 1944. Descriptive catalogue of the Formosan fungi. Rep. Dept. Agric. Gov. Res. Inst. Formosa 87:1-96.

Shetty HS, Safeeulla KM. 1980(1981). Teliospore germination and systematic position of *Neovossia vittata* (Berk.) comb. nov. Indian Phytopathol. 33:399-404.

Shivas RG, Vánky K. 2001. The smut fungi on *Cynodon,* including *Sporosorium normanensis* sp. nov. from Australia. Fungal Diversity 8:149-154.

Simon BK. 1993. A key to Australian grasses. 2nd ed. DPI Queensland. 206 pp.

Stoll M. 2001. *Ustilago/Sporisorium* (Ustilaginales) — Molekulare Phylogenie und Koevolution mit Gräsern (Poaceae). Dissertation, Tübingen, pp. 121.

Sydow H. 1924. Notizen über Ustilagineen. Ann. Mycol. 22:277-291.

— 1935. Beschreibungen neuer südafrikanischer Pilze. VI. Ann. Mycol. 33:230-237.

— 1937. Neue oder bemerkenswerte australische Micromyceten. I. Ann. Mycol. 35:22-49.

—, Petrak F. 1928. Micromycetes philippinenses. Series prima. Ann. Mycol. 26:414-446.

—, Sydow P. 1901. Mycologische Mittheilungen. Hedwigia, Beibl. 40:(1)-(3).

—, — 1909. Einige neue resp. bemerkenswerte Pilze aus Südafrika. Ann. Mycol. 7:543-547.

—, — 1914. Beschreibung neuer südafrikanischer Pilze. III. Ann. Mycol. 12:263-267.

—, — 1919. Mykologische Mitteilungen. Ann. Mycol. 17:33-47.

—, —, Butler EJ. 1906. Fungi Indiae orientalis. Pars I. Ann. Mycol. 4:424-445.

—, —, — 1907. Fungi Indiae orientalis. Pars II. Ann. Mycol. 5:485-515.

—, —, — 1912. Fungi Indiae orientalis. Pars IV. Ann. Mycol. 10:243-280.

Thaxter R. 1893. Fungi described in recent reports of the Connecticut Experiment Station. J. Mycol. 7:278-280.

Thirumalachar MJ, Mundkur BB. 1951. Revisions of and additions to Indian fungi. III. Mycol. Pap. 40:1-15.

—, Pavgi MS. 1953. Notes on some Indian Ustilagineae. VII. Sydowia 7:98-102 + Pl. V.

—, — 1967(1968). Notes on some Indian Ustilagineae. IX. Sydowia 20:21-27 + Pl. I.

—, — 1968(1969). Notes on some Indian Ustilagineae. X. Sydowia 22:250-253 + Pls. XV-XVI.

Tracy SM, Earle FS. 1895. New species of parasitic fungi. Bull. Torrey Bot. Club 22:174-179.

Vánky K. 1985a. Carpathian Ustilaginales. Symb. Bot. Upsal. 24(2):1-309.

— 1985b. K. Vánky, Ustilaginales exsiccata. Fasc. XIX-XX (No. 451-500). Publ. Herb. Ustilag. Vánky (HUV) 1:1-17.

— 1991. Taxonomical studies on Ustilaginales. VIII. Mycotaxon 41:483-495.

— 1992. Taxonomical studies on Ustilaginales. IX. Mycotaxon 43:417-425.

— 1994. European smut fungi. Gustav Fischer Verlag, Stuttgart, Jena, New York, 570 pp.

— 1995. Taxonomical studies on Ustilaginales. XIII. Mycotaxon 56:197-216.

— 1996. Taxonomical studies on Ustilaginales. XIV. Mycotaxon 59:89-113.

— 1997a. Taxonomical studies on Ustilaginales. XV. Mycotaxon 62:127-150.

— 1997b. Taxonomical studies on Ustilaginales. XVI. Mycotaxon 65:133-158.

— 1998a. The genus *Microbotryum* (smut fungi). Mycotaxon 67:33-60.

— 1998b. New Australasian Ustilaginales. Mycotaxon 68:327-344.

— 1998c. Ustilaginales exsiccata. Fasc. XLI–XLII (No. 1001–1050). Publications Herb. Ustilag. Vánky (HUV) 12:1–17.

— 1999. The new classificatory system for smut fungi, and two new genera. Mycotaxon 70:35-49.

— 2000a. Taxonomical studies on Ustilaginales. XX. Mycotaxon 74:161-215.

— 2000b. The smut fungi on *Saccharum* and related grasses. Australasian Pl. Pathol. 29:155-163.

— 2001. Taxonomical studies on Ustilaginales. XXI. Mycotaxon 78:265-326.

— 2002a. Taxonomical studies on Ustilaginales. XXII. Mycotaxon 81:367-430.

— 2002b. Illustrated Genera of Smut Fungi. 2nd. Ed. APS Press, 238 pp.

— 2003a. The smut fungi (Ustilaginomycetes) of *Hyparrhenia* (*Poaceae*). Fungal Diversity 12:179-205.

— 2003b. Taxonomical studies on Ustilaginales. XXIII. Mycotaxon 85:1-65.

— 2003c. Smut fungi (Ustilaginomycetes) of *Sporobolus* (*Poaceae*). Fungal Diversity 14:205-241.

—, Oberwinkler F. 1994. The smut fungi of Polygonaceae, a taxonomic revision. Beih. Nova Hedwigia, 107:1-96.

—, Sharma ND. 2001. A new *Tilletia* species (Tilletiales) from India. J. Mycopathol. Res. 39:71-72.

—, Shivas RG. 2001. New smut fungi (Ustilaginomycetes) from Australia. Fungal Diversity 7:145-174.

—, —. 2003. Further new smut fungi (Ustilaginomycetes) from Australia. Fungal Diversity 14:243-264.

Viégas AP. 1944. Alguns fungos do Brasil III. Ustilaginales. Bragantia 4:739-751.

Viennot-Bourgin G. 1959. Étude de micromicètes parasites récoltés en Guinée. Ann. Inst. Natl. Agron. 45:1-91.

Zundel GL. 1930. Monographic studies on the Ustilaginales attacking *Andropogon*. Mycologia 22:125-158.

— 1938. The Ustilaginales of South Africa. Bothalia 3:283-330.

— 1939. Studies on the Ustilaginales of the world. Mycologia 31:572-589.

— 1943. Notes on the Ustilaginales of the world. III. Mycologia 35:164-184.

— 1944. Notes on the Ustilaginales of the world. IV. Mycologia 36:400-412.

— 1945. Notes on a proposed new genus and four new species of the Ustilaginales. Mycologia 37:370-373.

— 1953. The Ustilaginales of the World. Pennsylvania State Coll. School Agric. Dept. Bot. Contrib. 176:XI + 1-410.

MYCOTAXON

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A new species of *Microstoma* from Taiwan

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Abstract–This paper describes and illustrates a new species, *Microstoma apiculosporum,* collected from Taiwan. It differs from *M. floccosum* by its apiculate ascospores.

Key words–discomycetes, Pezizales, *Sarcoscyphaceae*

Microstoma apiculosporum *sp. nov.* **FIGURES 1-2**

> *Ab Microstoma floccosum, ascosporis ellipsoideae, 25-30 x 9-10 μm, sporae extremae ambae apiculatae, apiculi hemisphaerici, 3-3.5 x 3-4 μm, 1-gelatinosa vaginata circumcincta.*

Apothecia scattered or gregarious on the substrate, stipitate, deeply cupulate, disc orange red, 0.4-0.8 cm wide, and 0.3-1 cm deep. **Margins** entire, incurved when dry. **Hairs** arising from ectal excipulum, hyaline, acute at the tip, 270-1200 x 12-15 μm, thick-walled, evenly distributed on surface of receptacle and stalk. **Stalk** cylindrical, 0.3-1.5 cm long, pale orange, base with dark brown hyphal mat. **Ectal excipulum** of *textura angularis,* polygonal cells 5-15 μm diam., tissues gelatinous, layer 30-50 μm thick, medullary excipulum of *textura porrecta,* hyphae regularly arranged, 3-4 μm wide, layer 50-80 μm thick, subhymenium 15-30 μm thick, orange, with short cylindrical cells, hymenium layer 350-400 μm thick, easily separated from excipular layer. **Asci** 8-spored, suboperculate, clavate, 325-335 x 12-14 μm, base usually contracted into a short narrow stalk. **Ascospores** ellipsoid, smooth, 25-30 x 9-10 μm, filled with oil droplets, apiculate at both ends of spores, apiculi hemispherical, 3-3.5 x 3-4 μm, surrounded with a gelatinous sheath when freshly released. **Paraphyses** branched, connected as a net around the asci, filled with many orange granules, 2-3 μm wide, septate.

Holotype: Taiwan, Nantou: Juiyenshi Nature Reserve, elev. 2400 m; on dead sticks of broadleaf tree, Sep. 24, 2003, coll. W. N. Chou, *WAN 1002* (TNM F15224).

Etymology: Latinized form of apiculate, referring to the apiculate ascospores.

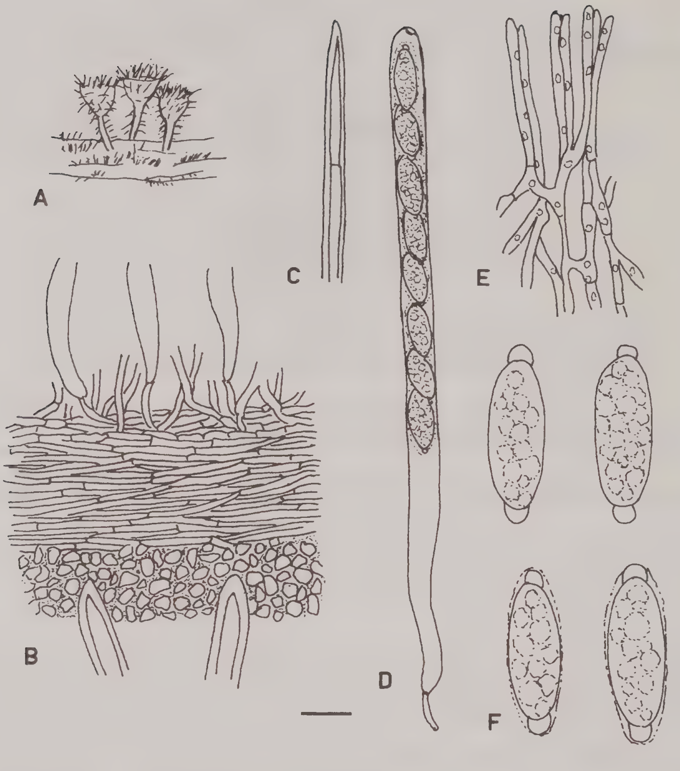

Fig. 1. *Microstoma apiculosporum*, holotype. A. Three apothecia. B. A part of excipulum C. The tip of a hair. D. An ascus. E. The upper part of paraphyses. F. Ascospores. Bar = 0.8 cm for A, 25 μm for B-D; 10 μm for E, F.

Additional specimen examined: Taiwan, Nantou: Juiyenhsi Nature Reserve, elev. 2400 m; on dead branches of broadleaf tree, Sep. 24, 2002, coll. W. N. Chou, *WAN 938* (TNM F14648).

This species is similar to *M. floccosum* (Schwein.) Raitv. and *M. macrosporum* (Y. Otani) Y. Harada and S. Kudo in the stipitate, hairy, orange colored apothecia, but the ascospores of *M. floccosum* are broader (14-16 μm in Kanuse, 1948; 10-13 μm in Wang, 2001) while those of *M. marcosporum* are larger (42-60 x 16-21 μm in Harada and Kudo, 2000; 50-56 x 19-24 μm in Zhuang and Wang, 1997), but neither of them is apiculate.

Four species of *Microstoma* are generally recognized, i.e., *M. aggregatum* Otani, *M. floccosum*, *M. macrosporum* and *M. protractum* (Fr.) Kanouse, and all have been

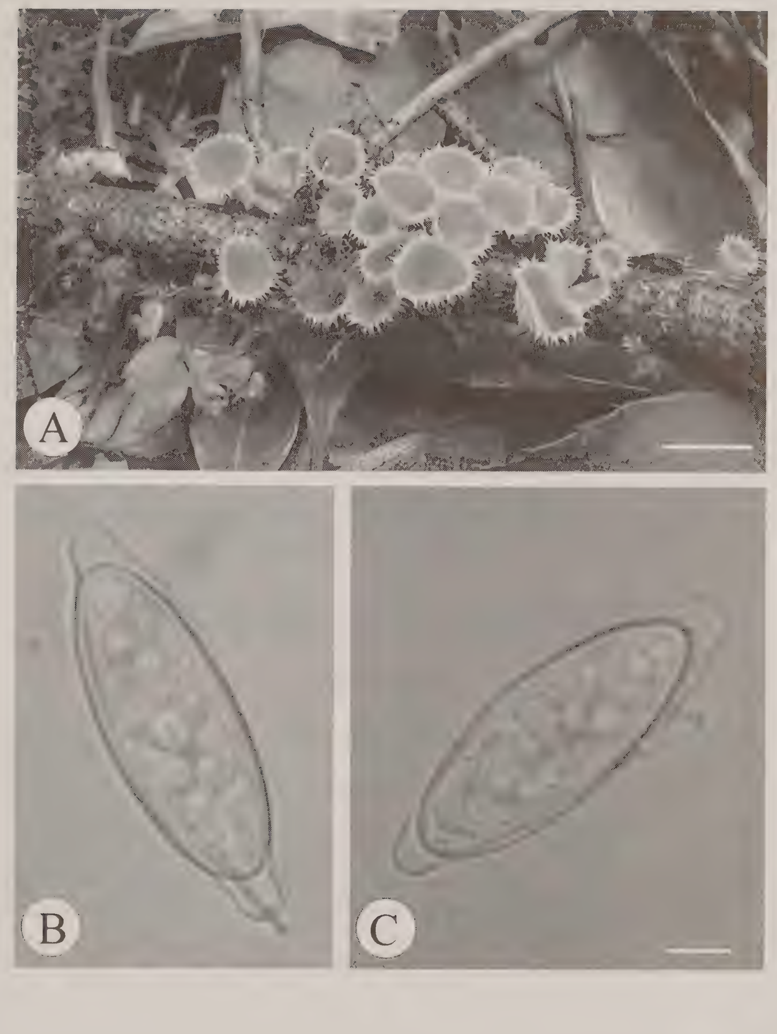

Fig. 2. *Microstoma apiculosporum*. A. Apothecia in the habitat. Bar = 1 cm. B. and C. An ascospore. Bar = 5 μm.

reported in Japan (Otani, 1990; Harada and Kudo, 2000). In Taiwan, only *M. floccosum* has been recorded, which usually occurs from February to May (Seaver, 1928; Wang, 2001).

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Literature Cited

Harada Y, Kudo S-i. 2000. *Microstoma macrosporum* stat. nov., a new taxonomic treatment of a vernal discomycete (Sarcoscyphaceae, Pezizales). Mycoscience 41: 275-278.

Kanouse BB. 1948. The genus *Plectania* and its segregates in North America. Mycologia 40: 482-497.

Otani Y. 1990. Miscellaneous notes on Japanese Discomycetes. Rept. Tottori Mycol. Inst. 28: 251-265.

Seaver FJ. 1928. The North American Cup-fungi (Operculates). 284 pp. New York.

Wang Y-Z. 2001. Discomycetes of the Sarcoscyphaceae in Taiwan. Mycotaxon 79: 329-336.

Zhuang W-y, Wang Z. 1997. Some new species and new records of Discomycetes in China VII. Mycotaxon 63: 307-321.

MYCOTAXON

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Further new species in the genus *Pertusaria* (Lichenized Ascomycota) fromThailand

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Abstract– *Pertusaria allothwaitesii, P. lansangensis, P. nanensis* and *P. takensis* from Thailand are reported as new to science.

Introduction

Although a number of new *Pertusaria* species from Thailand have recently been described (Jariangprasert *et al.* 2002, 2003), additional new species have now been discovered. The new taxa are distinguished from known species on the basis of the number of spores per ascus, thalline, apothecial and spore morphology and the medullary chemistry. The chemistry of new species were analyzed by thin layer chromatography (Elix & Ernst-Russell 1993) and confirmed by high performance liquid chromatography (Elix *et* *al.* 2003). The material examined is housed in RAMK (Lichen Research Unit, Ramkhamhaeng University, Bangkok), CMU (Chiang Mai University Herbarium), PSU (Department of Chemistry, Prince of Songkla University Herbarium) and the herbarium of S. Jariangprasert (SJ).

Taxonomic Descriptions

Pertusaria allothwaitesii Jariangprasert & A.W. Archer, *sp. nov* . **Figure 1**

Similis *Pertusaria thwaitesii* sed acida norsticticum, divaricaticum et barbaticum continens differt.

Etymology: from the Greek *allos* = other, and the species' resemblance to *P. thwaitesii.*

Type: **THAILAND**. **Phitsanulok Province**, Nakhon Thai District, Phu Hin Rongkla National Park, right hand side of the road from Mhun Daeng Waterfall at thirty-seventh kilometre stone, 1560 m, on bark of *Prunus cerasoides* D. Don, in evergreen hill forest, *S. Jariangprasert 2069*, 19.i.2002; holotype: RAMK; isotype: SJ.

KEY CHARACTERS — Thallus corticolous, off-white to pale grey, smooth, dull, lacking isidia and soredia. **Apothecia** verruciform, conspicuous, concolourous with the thallus, irregular in outline, numerous, scattered, with multiple ostioles, rarely confluent, not constricted at base. **Ostioles** numerous, conspicuous, pale grey to black, surrounded with translucent tissue, protruded and becoming evenly black, 1–8–many per verruca. **Ascospores** 2 per ascus, elongate ellipsoid, 120–166 µm long, 40–52 µm wide, rough; outer ascospore wall 6–12 µm thick.
Chemistry— K+ yellow then red, KC-, C-, Pd+ pale yellow–reddish yellow, UV-; norstictic acid (major), divaricatic acid (major/minor) and barbatic acid (minor to trace).

Ecology — *Pertusaria allothwaitesii* is a corticolous species found in north and north-eastern Thailand in evergreen and scrub forests at elevations of 1100 to 1560 m.

COMMENTS — *Pertusaria allothwaitesii* is distinguished from other *Pertusaria* species with two rough ascospores by its chemistry, and especially the presence of norstictic acid as a major compound combined with divaricatic and barbatic acids. *Pertusaria allothwaitesii* resembles *P. thwaitesii* Müll. Arg. as both have numerous, conspicuous black ostioles per verruca and two rough ascospores but they differ in their chemistry. *Pertusaria thwaitesii* contains protocetraric acid (Archer 1997) while *P.*

allothwaitesii contains norstictic, divaricatic and barbatic acids. *Pertusaria allothwaitesii* is found at elevations 1100 up to 1560 m.

REPRESENTATIVE SPECIMENS EXAMINED —THAILAND. Chiang Mai Province: Mueang District, Doi Suthep-Pui National Park, right wayside before a crossing to the Buddhist temple, 1500 m, on fallen log, evergreen hill forest, *S. Jariangprasert 1654*, 16.vii.2001 (*SJ*); *ibid.*, on the way to fire protection line, 1550 m., *S. Jariangprasert 1567*, 1.vi.2001 (*SJ*); Jom Thong District, Doi Inthanon National Park, gateway to Mae Raed Headwaters, 1100 m, on bark of *Betula alnoides* Buch.-Ham. ex G. Don, in evergreen hill forest, *S. Jariangprasert 2396*, 13.iii.2002 (*SJ*).

Nan Province: Pua District, Doi Phu Ka National Park, right wayside to Pua District between 35 and 36 kilometre stone, 1500 m, on bark of *Betula alnoides* in evergreen hill forest, *S. Jariangprasert 1584*, 9.vi.2001 (*SJ*).

Loei Province: Phu Luang Wildlife Sanctuary, Pha Somdej Cliff, 1500 m, on bark of *Rhododendron moulmeinense* Hook. f., in scrub forest, *S. Jariangprasert 2199*, 3.ii.2002 (*SJ*); *ibid.*, between Pha Somdej Cliff and Pha Chang Phan Cliff, on bark of *Lithocarpus truncatus* (King) Rehder & Wilson in scrub forest, *S. Jariangprasert 2228*, 3.ii.2002 (*SJ*).

Pertusaria lansangensis Jariangprasert & A.W. Archer, *sp. nov* **Figure 2**

Similis *Pertusaria cicatricosa* sed sorediis differt.

Etymology: from the Latin *ensis* = place of origin, and Lan Sang National Park.

Type: **THAILAND. Tak Province,** Lan Sang National Park, between Tak Province and Mae Sod District, on the way between Musoe Dam and Musoe Lhueang Agricultural Station, trail to Pha Daeng unit, ridge of mountain adjacent to bamboo forest, 980 m, on unidentified tree in evergreen hill forest, *S. Jariangprasert 3779*, 20.xi.2002; holotype: RAMK.

KEY CHARACTERS — **Thallus** corticolous, glaucous-green, smooth-slightly wrinkled, shiny, crystallized under cortex, sorediate, isidia absent. **Soralia** compact, granular, semicapitate, concolourous with the thallus, numerous, scattered, 0.4–1.0 mm diam. **Apothecia** verruciform, conspicuous, scattered, not confluent, not constricted at base, flattened, concolourous with thallus, 1.4–2.0 mm diam. **Ostioles** grey, conspicuous, punctiform, surrounded with white tissue, 6—0 per verruca. **Ascospores** 2 per ascus, ellipsoid-cylindrical, (100–)126–204 µm long, (30–)40–52 µm wide, rough; outer ascospore wall 10–22 µm thick.

Chemistry — K+ yellow, KC-, C-, Pd+ dull orange, UV+ reddish orange; 2,4-dichlorolichexanthone (minor), 2,5-dichlorolichexanthone (minor), 2,4,5-trichlorolichexanthone (minor), 2-chlorolichexanthone (trace), stictic acid (major) and constictic acid (minor).

Ecology — *Pertusaria lansangensis* is a rare corticolous species from north and northeastern Thailand.

REPRESENTATIVE SPECIMEN EXAMINED —THAILAND. Loei Province: Phu Luang Wildlife Sanctuary, 1470 m, in front of the old palace, on bark of unidentified tree in oak-dipterocarp forest, *S. Jariangprasert 2181*, 3.ii.2002 (SJ).

COMMENTS — *Pertusaria lansangensis* is characterised by verruciform apothecia, asci with 2 rough ascospores and the presence of the di- and trichlorinated lichexanthones and stictic acid. It resembles *P. cicatricosa* in both chemistry and morphology but is distinguished by the production of soredia which are absent in *P. cicatricosa* (Archer 1997). The new species is also distinguished from *P. cicatricosa* by the ratio of 2,4,5-trichlorolichexanthone to the isomeric dichlorolichexanthones (major and minor respectively in the latter species).

Pertusaria nanensis Jariangprasert & A.W. Archer, *sp. nov.* **Figure 3**

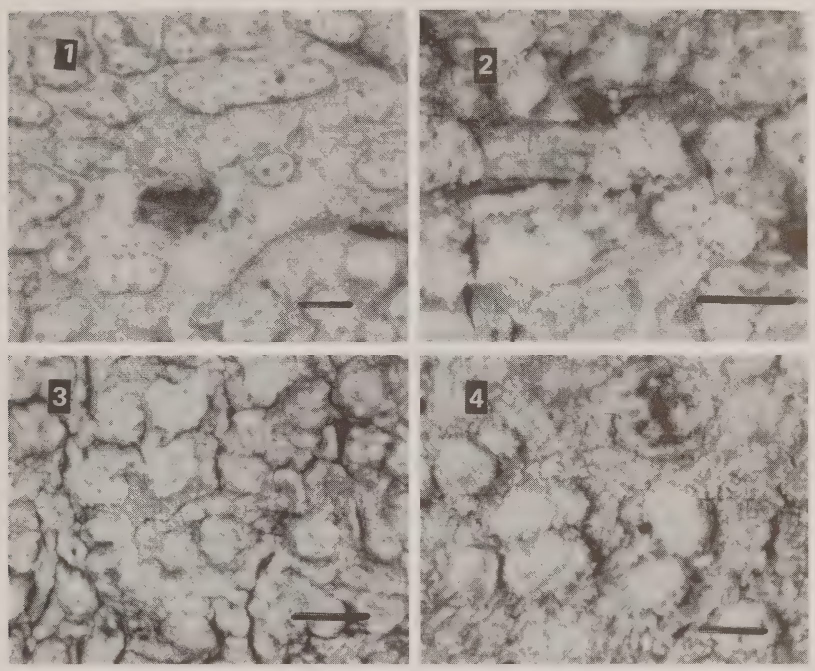
Similis P. alboaspera *sed acidum protocetraricum continens vice acidum sticticum et ostiolis nigris differt.*

Etymology: from the Latin *ensis* = place of origin, and Nan Province.

Type: **THAILAND. Nan Province,** Bo Khluea District, Bo Khluea Nhuea Community, right wayside before the fourteenth kilometre stone from Bo Kluea Nhuea to Bo Kluea District, 1000 m, on bark of Leguminosae, *S. Jariangprasert 1601*, 9.vi.2001; holotype: RAMK.

KEY CHARACTERS — **Thallus** corticolous, greyish ivory, smooth, dull, cracked and subtuberculate, lacking isidia and soredia. **Apothecia** verruciform, numerous, conspicuous, flattened hemispherical, crowded, rarely confluent, constricted at base, some irregular in outline, concolourous with the thallus, 0.5–0.9 mm diam. **Ostioles** conspicuous, grey to black, tapering or punctiform, slightly depressed, 1–2(–4) per verruca, 0.05–0.10 mm diam. **Ascospores** 8 per ascus, biseriate, subfusiform to ellipsoid, 60–98 µm long, 32–40 µm wide, smooth; outer ascospore wall 4–8 µm thick.
Chemistry: K+ pale yellow, KC-, C-, Pd+ scarlet red, UV+ yellow; lichexanthone (major), 2,2'-di-*O*-methylstenosporic acid (major) and protocetraric acid (minor).

Ecology — *Pertusaria nanensis* is an endemic corticolous species from Bo Khleua District in the north of Thailand and at present is known only from the type specimen.



Figures 1-4. New species of *Pertusaria*. **1**. *P. allothwaitesii* (holotype in RAMK); **2**. *P. lansangensis* (holotype in RAMK); **3**. *P. nanensis* (holotype in RAMK); **4**. *P. takensis* (holotype in RAMK). Scale bar = 1.0 mm.

COMMENTS — *Pertusaria nanensis* is characterised by verruciform apothecia, asci with 8 biseriate ascospores and the presence of lichexanthone, 2,2'-di-*O*-methylstenosporic and protocetraric acids. This species resembles *P. alboaspera* A.W. Archer & Elix and *P. alboaspera* var. *deficiens* Jariangprasert & A.W. Archer (Jariangprasert *et al*., 2003) but both of these taxa have inconspicuous, pale, translucent ostioles in contrast to the black ostioles present in *P. nanensis*. In addition, *P. nanensis* contains protocetraric acid rather than stictic and constictic acids present in *P. alboaspera* (Archer & Elix 1993). The absence of stictic acid in this new species also distinguishes it from the chemically and morphologically similar *P. verruculifera* Vain. from Brazil (Vainio 1890) and *P. congesta* Vain. [syn.: *P. glaucocinera* Vain.] from Angola (Vainio 1901).

Pertusaria takensis Jariangprasert & A.W. Archer, *sp. nov.* **Figure 4**

Similis Pertusaria cicatricosa *sed isidiis differt.*

Etymology: from the Latin *ensis* = place of origin, and Tak Province.

Type: **THAILAND**. **Tak Province**, Lan Sang National Park, between Tak Province and Mae Sod District, on the way between Musoe Dam and Musoe Lhueang Agricultural Station, trail to Pha Daeng unit, ridge of mountain adjacent to bamboo forest, 980 m, on unidentified tree in evergreen hill forest, *S. Jariangprasert 3832*, 20.xi.2002; holotype: RAMK.

KEY CHARACTERS — **Thallus** corticolous, yellowish green to glaucous green, smooth, isidiate, lacking soredia. **Isidia** conspicuous, simple, globose to cylindrical, 0.1 mm diam. 0.1–0.15 mm long. **Apothecia** verruciform, conspicuous, concolourous with thallus, numerous, scattered, flattened hemispherical, slightly concave, rarely confluent, constricted at base, 0.5–1.4 mm diam. **Ostioles** inconspicuous, grey, punctiform, surrounded with translucent tissue, slightly raised, 2–8 per verruca. **Ascospores** 2 per ascus, ellipsoid-cylindrical, (84–)116–180(–206) µm long, 30–50 µm wide, rough; outer ascospore wall 7–18 µm thick.
Chemistry: K+ yellow, KC-, C-, Pd+ orange, UV+ reddish orange; 2,4-dichlorolichexanthone (minor), 2,5-dichlorolichexanthone (minor), 2,4,5-trichlorolichexanthone (minor), 2-chlorolichexanthone (trace), stictic acid (major), constictic acid (minor) and ± atranorin (trace).

Ecology — *Pertusaria takensis* is a rare corticolous species from north and northeastern Thailand.

REPRESENTATIVE SPECIMEN EXAMINED —**THAILAND. Nakhon Ratchasima Province**: Khao Yai National Park, Khao Khiao, roadside to the Radar Station, 1180 m, on bark of unidentified tree in evergreen hill forest, *S. Jariangprasert 1319*, 17.xii.2000 (SJ).

COMMENTS — *Pertusaria takensis* is characterised by verruciform apothecia, asci with 2 rough ascospores and the presence of the di- and tri-chlorinated lichexanthones and stictic acid. It resembles both *P. cicatricosa* and *P. subisidiosa* in chemistry, but is distinguished from *P. cicatricosa* by the presence of isidia and from *P. subisidiosa* by the four smaller, rough ascospores and black ostioles (Archer 1991, 1997). *Pertusaria takensis* also differs from both *P. cicatricosa* and *P. subisidiosa* in the ratio of 2,4,5-trichlorolichexanthone to the isomeric dichlorolichexanthones (major and minor respectively in the latter taxa).

CORRECTION

In our previous paper describing *Pertusaria* taxa from Thailand (*Mycotaxon* **85**: 291. 2003), the published photographs were numbered incorrectly. The top left-hand photograph should be numbered **4**, the top right-hand photograph **3**, the lower left-hand photograph **2**, and the lower right-hand photograph **1**.

Acknowledgements

The authors are grateful to the RAMK, CMU and PSU herbaria for the loan of specimens and to Professor J.A. Elix (Australian National University) for the liquid chromatography results and editorial assistance; SJ is grateful to the Royal Golden Jubilee Ph. D. Program, The Thailand Research Fund for generous financial support, to the Royal Forestry Department for permission to collect specimens, to the Department of Biology, Chemistry, Faculties of Science, Maejo University for the use of the laboratories and equipment.

Literature Cited

Archer AW. 1991. New species and new reports of *Pertusaria* (lichenised Ascomycotina) from Australia and New Zealand with a key to the species in Australia. Mycotaxon **41**: 223–269.

Archer AW. 1997. The lichen genus *Pertusaria* in Australia. Biblioth. Lichenol. **69**: 1–249.

Archer AW, Elix JA. 1993. Additional new taxa and a new report of *Pertusaria* (lichenised Ascomycotina) from Australia. Mycotaxon **49**: 143-150.

Dibben MJ. 1980. The chemosystematics of the lichen genus *Pertusaria* in North America north of Mexico. Milwaukee Publications in Biology and Geology **5**: 1–162.

Elix JA, Ernst-Russell KD. 1993. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic Relationships for Lichen Substances. (2nd Edition). Australian National University, Canberra.

Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. Biblioth. Lichenol. **86**: 1–7.

Jariangprasert S, Archer AW, Elix JA, Anusarnsunthorn V. 2002. Two new species in the lichen genus *Pertusaria* (Ascomycotina) from Thailand. Mycotaxon **83**: 353–356.

Jariangprasert S, Archer AW, Elix JA, Anusarnsunthorn V. 2003. New taxa in the lichen genus *Pertusaria* (lichenized Ascomycotina) from Thailand. Mycotaxon **85**: 289–295.

Vainio, EA. 1890. Étude sur la classification naturelle et la morphologie des lichens du Brésil. Acta Soc. Fauna Fl. Fenn.. 7(1): 1–247.

Vainio, EA. 1901. Lichenes, in Catalogue of African Plants collected by F. Welwitsch in 1853–1861. **2(2):** 396–463, British Museum (Natural History), London.

MYCOTAXON

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Cryptosporiopsis actinidiae sp. nov.

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Abstract—A fungus commonly isolated from fruit rots of kiwifruit in New Zealand, referred to previously in the New Zealand literature as *Cryptosporiopsis* sp., is described here as *Cryptosporiopsis actinidiae*. It is reported from the kiwifruit species *Actinidia arguta, A. chinensis, A. deliciosa* and *A. indochinensis*, as well as apple. Although the teleomorph of *C. actinidiae* is unknown, it is genetically similar to the teleomorph genus *Neofabraea*, which includes the widespread fruit rot pathogens *N. alba, N. malicorticis* and *N. perennans*.

Keywords—ITS, phylogeny, *Pezicula*

Introduction

A fungus commonly associated with fruit rots of kiwifruit species (*Actinidia* spp.) has been reported in the New Zealand literature as *Cryptosporiopsis* sp. (Hawthorne et al. 1982, Pennycook 1989, Brook 1990, Manning & Lallu 1997, Manning et al. 2003). Microscopically it is similar to the *Cryptosporiopsis* anamorphs of *Neofabraea* as described by Verkley (1999). In cultural appearance it is similar to the widespread apple pathogen *Neofabraea malicorticis* H.S.Jacks., although the kiwifruit pathogen differs in the intense orange-red colour of cultures on agar plates (Hawthorne et al. 1982). Despite this fungus being isolated commonly from kiwifruit fruit rots and from the surface of intact fruits, fruiting bodies have not been found in the field and the fungus is known from only the asexual state in culture. A recent publication on phylogenetic relationships amongst *Neofabraea* species (de Jong et al. 2001) has allowed this kiwifruit pathogen to be compared reliably with known species. Given that this fungus significantly limits the storage life of the kiwifruit cultivar Hort 16A (Manning et al. in press), a species name for it is important.

Methods

Cultures are described from colonies grown on Difco potato dextrose agar (PDA) and oatmeal agar (OA) for 14 days in 12 h darkness/12 h light (near ultra-violet and 'BLB' and 'Cool White' fluorescent tubes) at about 20°C. Colour notations are from Kornerup & Wansher (1963). Conidia and conidiogenous cells from cultures were measured and described in 100% lactic acid. The cultures studied have been stored in ICMP (International Collection of Microorganisms from Plants, Landcare Research, Auckland) and dried cultures derived from these have been stored in PDD (New Zealand Fungal Herbarium, Landcare Research, Auckland).

Extraction and amplification of DNA. Cultures were grown in 20 ml Vogel N medium amended with sucrose 1% and yeast extract 0.5% (Vogel 1964) in petri dishes in the dark at 18–20℃ for 4 days. The cultures were filtered through Miracloth (Calbiochem), and the mycelium dried between paper tissues. The mycelium was dried by vacuum centrifuge (SpeedVac, USA) for 1 hour, then ground with liquid nitrogen in a mortar and pestle. The genomic DNA was isolated with DNeasy Plant Mini Kit (QIAGEN, USA). PCR reactions were carried out as described by White et al. (1990), with FastStart Taq enzyme (Roche) on a GeneAmp PCR system 9700 (Applied Biosystems). The complete ITS region (ITS1, ITS2 and 5.8S) was amplified using the primers ITS1 and ITS4, which anneal to the flanking small subunit and large subunit nrDNA, respectively (White et al. 1990). PCR conditions were 1 cycle at 95 ℃ for 4 min, 35 cycles at 94 ℃ for 1 min., 45 ℃ for 1 min., 72 ℃ for 1 min., and a final cycle at 72 ℃ for 7 min. PCR product was purified with High Pure PCR Product Purification kit (Roche, USA). Sequencing reactions were performed with ABI PRISM BigDye Terminator v 3.1 Ready Reaction Kit (Applied Biosystems) and run on an Applied Biosystems ABI prism 310 Genetic Analyser. Sequence data were analysed and edited with Sequencher v3.1 software.

Isolates included in the phylogenetic analysis are listed in Table 1. Sequences were aligned using Clustal W (Thompson et al. 1994). A neighbor-joining analysis was performed with PAUP* 4.0b10 (Swofford 2002) using Jukes-Cantor distances. A bootstrap analysis (1000 replicates) was used to test the tree. The tree has been presented with *Pezicula cinnamomea* as the outgroup.

Taxonomic Description

Cryptosporiopsis actinidiae P.R.Johnst., M.A.Manning & X.Meier, sp. nov. —Fig. 1

Ab Cryptosporiopse curvispora, conidiis (7.5–) 9–14 × 3–5.5 µm, culturis crocea.

Etymology: from the host substrate

Holotype: New Zealand: Bay of Plenty: Te Puke, on rotting fruit of *Actinidia deliciosa*, coll. G.J. Samuels, 1 Sept 1982, PDD 77784 (ex-type culture, ICMP 7826).

Cultures on PDA 45–50 mm diam. after 14 days, aerial mycelium more or less lacking, slimy in appearance, surface covered with copious conidial ooze, from above cultures intense reddish-orange to brownish-orange in colour (7B8 to 7C8), deep orange (6A8) in narrow zone near margin, margin itself colourless, similar variation in colour from below, yellow pigment diffusing into agar surrounding culture. On OA aerial mycelium sparse, cottony, white, centre part of colony covered with whitish conidial ooze, agar surface red (11B7), colony red from below. Conidiogenous cells 8.5–14.5 × 3–4 µm, more or less cylindric, tapering to narrow apex, indistinct flaring collarette and wall barely thickened at the single, apical conidiogenous locus. Conidiogenous cells usually held on irregularly branched conidiophores, sometimes arising directly from hyphae, sometimes with acropleurogenous conidiogenous loci. Conidia (7.5–) 9–14 × 3–5.5 µm, oblong-elliptic, elliptic or ovate, straight to slightly and irregularly curved, ends broadly rounded, with indistinct scar at base, 0-septate.

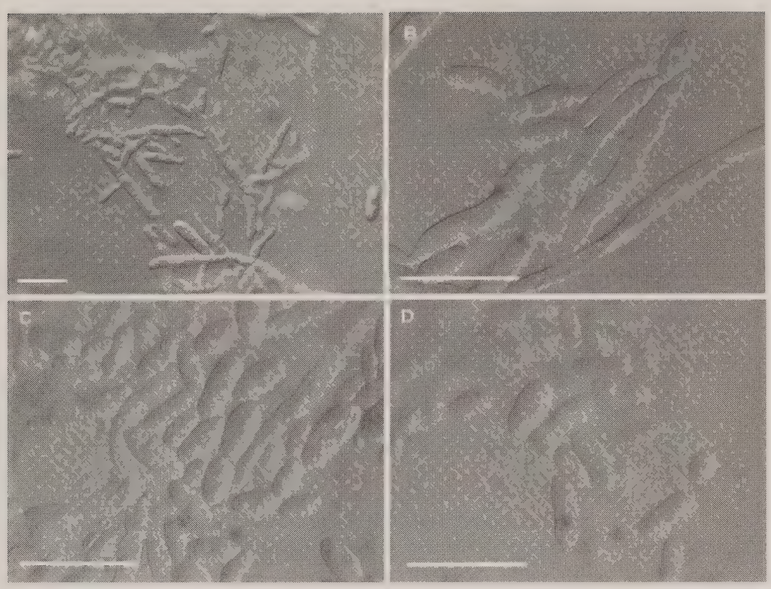

Fig 1. *Cryptosporiopsis actinidiae* (ICMP 7826). A–B, conidiogenous cells and conidiophores. C–D, conidia. Scale bars = 20 μm.

NOTES: The conidia of *C. actinidiae* are smaller than those described by Verkley (1999) for all other *Cryptosporiopsis* anamorphs of *Neofabraea*. The intense red to orange colours of the cultures are characteristic of this species, and distinguish it from the other *Neofabraea* species reported from New Zealand (*N. alba* (E.J.Guthrie) Verkley and *N. malicorticis*). The morphological differences are reflected in the ITS sequences (see phylogenetic analysis below), which show *C. actinidiae* to be also genetically distinct.

C. actinidiae has been isolated from the fruits of several kiwifruit species (*Actinidia arguta*, *A. chinensis*, *A. deliciosa*, and *A. indochinensis*), as well as apple. It has not been associated with important diseases of apple, and the single isolate known from apple (ICMP 10738) may have been a chance infection of a ripe fruit. *C. actinidiae* may have a wider host range than currently recognised, but to date it is of economic significance on kiwifruit alone.

Phylogenetic Analysis and Discussion

The neighbor-joining analysis (Fig. 2) shows that *C. actinidiae*, presently known only from its asexual state, is likely to have a *Neofabraea* teleomorph. At the species level it is genetically distinct from all described *Neofabraea* species, as well as the undescribed species from apple reported by de Jong et al. (2001).

C. actinidiae has been isolated from the fruits of apple as well as kiwifruit. The *Neofabraea* species reported from apple in New Zealand are *N. alba* and *N. malicorticis* (Dingley 1969, Pennycook 1989, in both publications as *Pezicula alba* E.J.Guthrie and *P. malicorticis* (H.S.Jacks.) Nannf.). Isolates of *N. alba* in the ICMP culture collection genetically match *N. alba* sensu de Jong et al. (2001) (ICMP 12583, ITS sequence deposited in Genbank as AY359235; ICMP 11020, ITS sequence deposited in Genbank as AY359236). Apart from *Neofabraea alba*, most *Neofabraea* isolates from apple in New Zealand have cultures darker in colour than *C. actinidiae* (M. A. Manning, unpublished data), and appear to match morphologically *N. malicorticis* and *N. perennans* Kienholz sensu de Jong et al. (2001). The only ICMP isolate from apple identified as *N. malicorticis* (ICMP 10738) had an ITS sequence matching *C. actinidiae*. The frequency of *C. actinidiae* on apple in New Zealand remains unknown.

The pathogen *Neofabraea perennans* has been considered a synonym of *N. malicorticis* in the New Zealand literature (Dingley 1969, Pennycook 1989). Following the demonstration by de Jong et al. (2001) that these names represent two distinct fungi, a molecular survey of the *Neofabraea* species on apple in New Zealand would be timely.

Table 1. Details of isolates used in the phylogenetic analysis. GenBank accessions annotated with * were generated as part of this study.

Culture name	Host	Voucher specimen	GenBank accession number
Cryptosporiopsis actinidiae	*Actinidia arguta*	ICMP 15066	*AY359233
C. actinidiae	*Actinidia chinensis*	ICMP 15025	*AY359226
C. actinidiae	*Actinidia chinensis*	ICMP 15026	*AY359227
C. actinidiae	*Actinidia chinensis*	ICMP 15027	*AY359228
C. actinidiae	*Actinidia chinensis*	ICMP 15024	*AY359229
C. actinidiae	*Actinidia deliciosa*	ICMP 7826	*AY359232
C. actinidiae	*Actinidia indochinensis*	ICMP 14423	*AY359231
C. actinidiae	*Malus* x *domestica*	ICMP 10738	*AY359234
C. actinidiae	*Actinidia chinensis*	ICMP 13964	*AY359230
Neofabraea alba	*Malus*		AF281370
N. alba	*Malus*		AF281366
N. alba	*Malus*		AF281377
N. alba	*Malus*		AF281374
N. alba	*Malus*		AF281378
N. krawtzewii	*Populus*		AF281365
N. malicorticis	*Malus*		AF281379
N. malicorticis	*Malus*		AF281385
N. malicorticis	*Malus*		AF141161
Neofabraea perennans	*Malus*		AF281392
Neofabraea sp.	*Malus*		AF141189
Neofabraea sp.	*Malus*		AF281398
Pezicula corticola			AF141179
Pezicula cinnamomea	*Betula*		AF281399

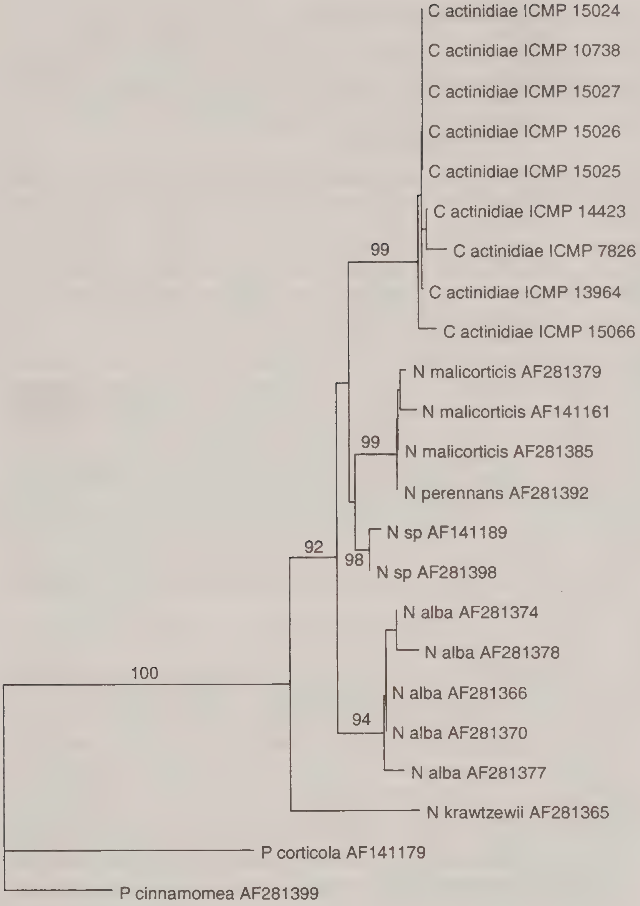
C actinidiae ICMP 15024
C actinidiae ICMP 10738
C actinidiae ICMP 15027
C actinidiae ICMP 15026
C actinidiae ICMP 15025
C actinidiae ICMP 14423
99
C actinidiae ICMP 7826
C actinidiae ICMP 13964
C actinidiae ICMP 15066
N malicorticis AF281379
N malicorticis AF141161
99
N malicorticis AF281385
N perennans AF281392
N sp AF141189
92
98
N sp AF281398
N alba AF281374
N alba AF281378
100
N alba AF281366
94
N alba AF281370
N alba AF281377
N krawtzewii AF281365
P corticola AF141179
P cinnamomea AF281399

Fig. 2. Neighbor-joining tree comparing *Cryptosporiopsis actinidiae* with *Neofabraea* species studied by de Jong et al. (2001); *Pezicula cinnamomea* as outgroup. Bootstrap values recorded where above 50%. Details of isolates in Table 1.

Acknowledgments

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References

Brook PJ. 1990. Diseases of kiwifruit. In Warrington IJ, Weston GC (Eds.) Kiwifruit: science and management. New Zealand Society for Horticultural Science. Palmerston North, New Zealand.

de Jong SN, Lévesque CA, Verkley GJM, Abeln ECA, Rahe JE, Braun PB. 2001. Phylogenetic relationships amongst *Neofabraea* species causing tree cankers and bull's-eye rot of apple based on DNA sequencing of the ITS nuclear rDNA, mitochondrial rDNA, and the β-tubulin gene. Mycological Research 105: 658–669.

Dingley JM. 1969. Records of plant diseases in New Zealand. New Zealand Department of Scientific and Industrial Research, Bulletin 192. Wellington.

Hawthorne BT, Rees-George J, Samuels GJ. 1982. Fungi associated with leaf spots and post-harvest fruit rots of kiwifruit (*Actinidia chinensis*) in New Zealand. New Zealand Journal of Botany 20: 143–150.

Kornerup A, Wanscher JH. 1963. Methuen Handbook of Colour. Methuen & Co. Ltd. London.

Manning MA, Lallu N. 1997. Fungal diseases of kiwifruit stored in controlled atmosphere conditions in New Zealand. Acta Horticulturae 444: 725–731.

Manning MA, Meier X, Olsen TL, Johnston PR. 2003. Fungi associated with fruit rots of *Actinidia chinensis* 'Hort16A' in New Zealand. New Zealand Journal of Crop and Horticultural Science 31: 315-324.

Pennycook SR. 1989. Fungal plant diseases recorded in New Zealand, Volume 2. Auckland, Plant Diseases Division, DSIR.

Swofford DL. 2002. PAUP*. Phylogenetic analysis using parsimony (*and other methods). Version 4. Sinauer Associates, Sunderland, Massachusetts.

Thompson JD, Higgins DJ, Gibson TJ. 1994. CLUSTAL W: Improving the sensitivity of progressive multiple sequence alignment through sequence weighting, position specific gap penalties and weight matrix choice. Nucleic Acids Research 22: 4673–4680.

Verkley GJM. 1999. A monograph of the genus *Pezicula* and its anamorphs. Studies in Mycology 44: 1–180.

Vogel, HJ. 1964: Distribution of lysine pathways among fungi: evolutionary implications. American Naturalist 98: 435–446.

White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification of direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pp. 315–322 in Innis MA, Gelfand DH, Sninsky JJ, White TJ (Eds.) PCR Protocols: a guide to methods and applications. Academic Press, San Diego.

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Variability of spore length in some species of the genus *Preussia (Sporormiella)*

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Abstract—Nine *Preussia* and *Sporormiella* isolates belonging to six different species (*P. australis, P. intermedia, S. grandispora, P. minima, P. minimoides* and *S. similis*) were studied for the variation of the morphological characters used to distinguish these species upon repeated transfers. A large variability of morphological features was observed among different subcultures from the same strain; in some cases, the ascospore length particularly made a reliable identification difficult at species level. These results revealed a high diversity and instability of some morphological characters within the genus *Preussia*. Taxonomic implications are discussed and *P. grandispora* and *P. similis* are also proposed as new combinations.

Key words—Ascomycetes, coprophilous, fungi, taxonomy

Introduction

The genus *Sporormiella* Ell. & Everh. (1892), was erected to comprise species of the Dothideales with ostiolate ascomata, pluricelled ascospores of 4-16 cells with a gelatinous sheath, provided with germ slits and an exclusively coprophilous habitat. Other related genera had been erected in the family Sporormiaceae, such as *Sporormia* De Not. (1845), *Preussia* Fuckel (1866) or *Westerdykella* Stolk (1955), defined by differential features such as habitat and the morphology of ascomata and ascospores. The recognition of the different genera in the Sporormiaceae was confused by their shared features (Auerswald 1866, Munk 1957). Ahmed & Cain (1972) made a revision of *Sporormia* and *Sporormiella* describing numerous new species in the latter genus and included an identification key to both genera, which remains as the main reference for the identification of the species. Moreover, Cain (1961) published a revision of the genus *Preussia* that included species from soil, plant debris and dung, the difference between *Preussia* and *Sporormiella* being the absence of ostiolate ascomata in *Preussia*. However, it has been proved (Arx 1973, Valldosera & Guarro 1990) that these morphological features are variable in culture and are influenced by culture nutrients, light and humidity (Valldosera & Guarro

1990, Guarro et al. 1997). Other studies (Arx & Aa 1987) distinguished both genera based on their natural habitat, limiting *Sporormiella* strictly for coprophilous species whereas *Preussia* would include species isolated from plant debris, wood or soil. However, it has been demonstrated that this distinction is inconsistent, due to the existence of species such as *P. aquilirostrata* Guarro, Abdullah, Gené & Al-Saadoon or *P. intermedia* (Auersw.) S.I. Ahmed reported from soil, plant debris or dung (Guarro et al. 1997). This led us to consider *Preussia* and *Sporormiella* as synonyms. Some new *Preussia* and *Sporormiella* species have been described in recent years, and the convenience or not of treating both genera as synonyms has continued (Barrasa & Checa 1991, Lorenzo 1994, Korolyova 2000, Richardson 2001).

During a study attempting the molecular characterization of 38 *Preussia* isolates preliminarily identified as belonging to the species *P. intermedia*, *P. australis* (Speg.) Arx, *P. minima* (Auersw.) Arx and *P. minimoides* (S.I. Ahmed & Cain) Valldosera & Guarro, from diverse geographical origins, we found that some diagnostic features, like the spore length or the positioning of the germ slit, were not reproducible in sporulating subcultures, to such a degree that the same isolate could be identified as a different species depending on the subculture examined. The principal aim of this work is to assess the variability in culture of the diagnostic morphological characters defining the mentioned *Preussia* species. With this goal, nine *Preussia* isolates were subjected to sequential subculturing up to four times and in two different culture media, and the morphology of the ascospores produced was studied in detail.

Materials and Methods

All the strains studied were isolated by the authors and are preserved in the CIBE-Merck, Sharp & Dohme Culture Collection in 20% glycerol vials, as 0.6 mm diam frozen agar plugs at –80°C. The geographical origin and isolation substrata of the nine isolates are listed in Table 1. The strains were grown at 22°C and 80% relative humidity on PDA (Potato Dextrose Agar, Difco) and OTM (Oat Meal Agar, Difco). Two initial cultures from each strain were obtained by directly inoculating the frozen agar plugs derived from the original isolation plate onto two plates (one PDA and one OTM). Four sequential transfers were obtained by inoculating small agar squares (5x5 mm), taken from the margin of 7-day-old colonies, at the center of a new plate. Each subculture was inoculated from the previous transfer. To induce the sporulation, the cultures were exposed to alternate cycles of 12h UV/daylight for at least 14 days. The asporogenous cultures were also grown in CMA (Corn Meal Agar, Difco) and WA (Water Agar, Pronadisa), to try to induce the production of ascomata, without success.

Table 1. Geographical origin and isolation substrata.

Strain code	Initial taxonomy	Geographical Origin	Isolation Substrata
S9	*P. intermedia*	Hester Malan Reserve (South Africa)	Zebra dung
S11	*P. minimoides*	Fae East route. (Namibia)	Gemsbok scat dung
S15	*P. minimoides*	Hlhluwe, Zululand (S. Africa)	Zebra dung
S17	*P. australis*	Llano de los Viejos. Tenerife (Spain)	*Viburnum tinus* debris
S19	*S. similis*	Mouth Miller Canyon. Arizona (USA)	Dung
S25	*P. minima**	Puerto Rico	Plant debris
S34	*P. australis*	Villuercas, Cáceres (Spain)	*Daphne gnidium* leaves
S35	*P. minimoides*	Ritigala (Sri Lanka)	Goat dung
S37	*S. grandispora*	Ontígola, Aranjuez (Spain)	*Phragmites communis* leaves

*Epithet assigned based mainly on the presence of a kink in the germ slit, since the spore length did not fit exactly with the description of *P. minima*.

The microscopic features were examined and measured after sporulation of four sequential transfers on PDA and OTM media for each strain. The slides were made using a Leica Wild M8 dissection scope, on water or lactophenol cotton blue, and observed under a Leitz Diaplan microscope. The terminology used in this work for the microscopic features follows Ahmed & Cain (1972). The measurements of ascospore size did not include the gelatinous sheath. We made 21 measurements from each sporulating subculture to define the range of the spore length, following the recommendations of Heinemann & Rammeloo (1985). All the measurements obtained were represented in box-plot graphs, showing the median and 25 and 75 percentiles of each distribution, to give a more realistic view of the sporal length ranges for each strain. We included isolate S37 *S. grandispora* (Speg.) S.I. Ahmed & Cain as an outgroup of the species object of study, differing in the referred morphological features.

Results

According to the results obtained, and following Valldosera & Guarro (1990) and Guarro et al. (1997), we considered *Preussia* and *Sporormiella* as synonyms. Therefore, the generic name *Preussia* will be used across this paper, and we propose the following new combinations:

***Preussia grandispora* (Speg.) Barrasa & Arenal, comb. nov.**

≡ *Sporormia grandispora* Speg., *Fungi Copr. Ven.* 1: 230. 1878. (basionym).

≡ *Sporormiella grandispora* (Speg.) S.I. Ahmed & Cain in Krug., *Trans. Bot. Soc. Edinb.* 41 (2): 198. 1971.

≡ *Preussia grandispora* (Speg.) Barrasa, comb. inval. *Contribución al estudio de los Ascomycetes coprófilos en España. Universidad de Alcalá de Henares*: 149. 1985. Doctoral Thesis ined.

***Preussia similis* (Khan & Cain) Arenal, comb. nov.**
≡ *Sporormiella similis* Khan & Cain, *Can. J. Bot.* 57: 1178. 1979. (basionym).

The study was focused on the determination of the spore size and the morphology of the germ slit. We identified the strains, initially attending to the length of spores and germ slit features of the initial cultures obtained from the frozen agar plugs in both media, PDA and OTM. Although epithet names were assigned (Table 1), differences in the features established by Ahmed & Cain (1972) to differentiate these species, made the specific identifications doubtful, at least, for some of the cases. A more in depth study of the nine strains following the subculturing experiment described in Materials and Methods allowed us to differentiate five different morphotypes, as indicated in Table 2.

Table 2. Spore length ranges and germ slit features for the nine *Preussia* isolates studied.

Strain	**Morphotype code**	**Observed spores**	**Ascospore Length**		**Germ Slit**			
			Range	**Median**	**D**	**O**	**P**	**Morphology**
S9	I-P	105	45.5-65	53.5	no	no	yes	straight, occasionally sinuous
S11	ML	210	26-40.5	34	yes	no	no	sigmoid
S15	AM	210	30.5-42	36.5	no	yes	yes	sinuous
S17	AM	168	32.5-44	38	no	yes	no	straight, occasionally sinuous
S19	*P. similis*	210	33.5-54	45.5	yes	no	no	straight
S25	MiA	168	28.5-41.5	36.5	no	no	yes	kink
S34	A-P	126	32.5-47	40.5	no	yes	yes	straight
S35	ML	210	22.5-40.5	34	yes	no	no	sigmoid
S37	*P.grandispora*	210	42-55.5	48	yes	no	no	straight

For germ slit features, the codes are: D: Diagonal; O: Oblique and P: Parallel. Identification and morphotype codes. AM: spore features between *P. australis* and *P. minimoides*. A-P: *P. australis* with parallel germ slit. I-P: *P. intermedia* with parallel germ slit. MiA: spore features between *P. minima* and *P. australis* with sinuous germ slit. ML: *P. minimoides* with large spores.

The results of the measurements of spore length in the original cultures and throughout the transfers obtained are shown in Figures 1 to 9. Lines are drawn showing the two thresholds established in the key by Ahmed

& Cain (1972) to distinguish between *P. australis* and *P. intermedia* "47 µm" and between *P. australis* and *P. minima*/*P. minimoides* "37 µm". The limits of the box-plots indicate the 25 and 75 percentiles of the distribution of data, the line into the boxes shows the median and the upper and lower limits of the whiskers covering 95% of the population.

In isolate S9 (Fig. 1), initially identified as *P. intermedia*, all the subcultures on PDA were asporogenous, whereas those in OTM were fertile. We made 105 spore measurements, and 22% of them were outside of the range (48-59 µm) established by Ahmed & Cain (1972), clearly exceeding the upper limit. However, the median was 53.5 µm, well within the limits defined by those authors. Interestingly, the germ slit was parallel instead of oblique to diagonal. Therefore, this strain showed some variability, but it was basically within the sporal range attributed to *P. intermedia*.

- **S9. Morphotype I-P**

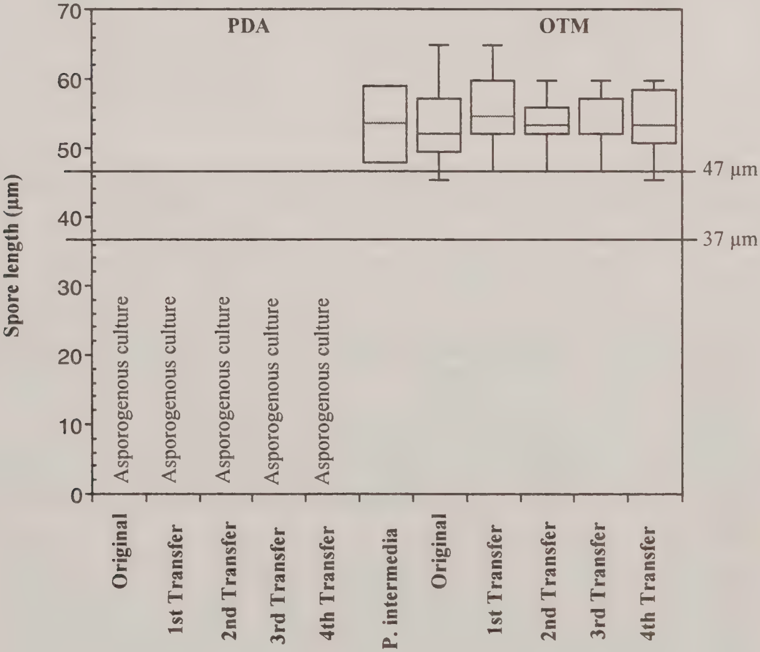

Fig. 1. Spore length of isolate S9 in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. intermedia* is shown in the center of the graph.

• S11. Morphotype ML

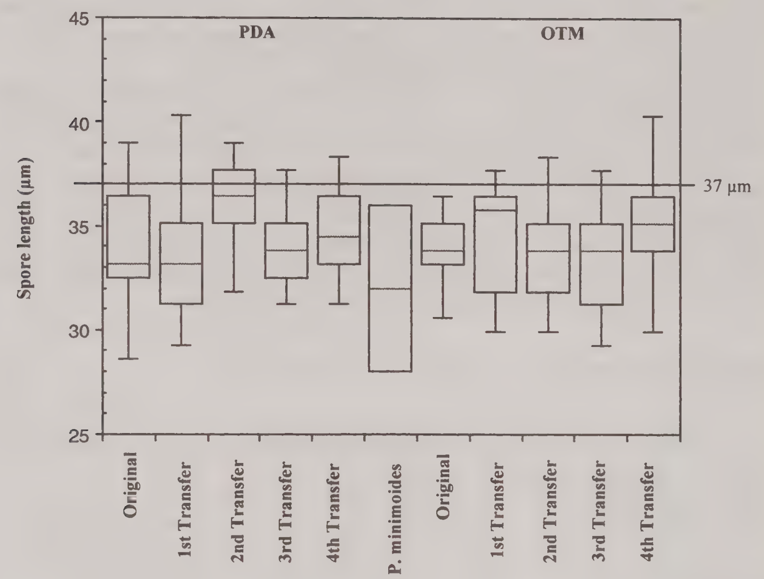

Fig. 2. Spore length of S11 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. minimoides* is shown in the center of the graph.

In isolate S11, initially determined as *P. minimoides* (Fig. 2), all the subcultures were fertile. From 210 measurements, 27% exceeded the upper limit "36 µm" indicated in the key. Attending to the medians, all the subcultures fell within the theorical range of size established by Ahmed & Cain for *P. minimoides*, except for the 2nd transfer in PDA, which showed a median of 36.5 µm and was the only subculture with the percentile 75 beyond the "37 µm" threshold, indicating that more than half of the spores measured exceeded the limit of "36 µm" given by the authors to delimit the species. The germ slit was always diagonal, in agreement with Ahmed & Cain (1972).

Almost 57% of the 210 spores measured in isolate S15, initially identified as *P. minimoides*, exhibited dimensions larger than 36 µm (Fig. 3). Although the two original cultures fell within the range of *P. minimoides*, it is noticeably that most of the subcultures obtained therefrom were not. As many as five of the transfers obtained showed distributions with medians higher than 37 µm. In particular, the 1st transfer in OTM showed a distribution that was more in agreement with the size range described for *P. australis*. Taking the data as a whole, the median of the distribution of spore size data was 36.5 µm. This, in combination with the oblique to parallel disposition of the germ slit, could exclude this strain from the concept of *P. minimoides* (Ahmed & Cain 1972).

• S15. Morphotype AM

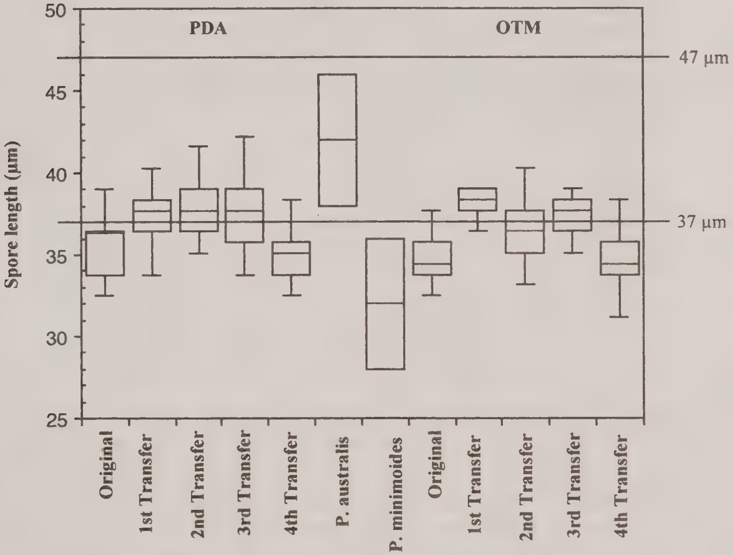

Fig. 3. Spore length of S15 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. australis* and *P. minimoides* are shown in the center of the graph.

A total of 168 measurements were made from isolate S17, initially determined as *P. australis*, since two subcultures (the last ones in both culture media) resulted asporogenous. Only the original culture in PDA showed spore dimensions fitting approximately the range given for *P. australis*, with a median of 39 µm, just above the lower limit of the description provided by Ahmed & Cain (1972). The remaining subcultures were in variable degree below that lower limit, and the medians of the distributions were consistently in between the size ranges given for *P. australis* and *P. minimoides*. Overall, 41% of the spores measured were under the length range for *P. australis*, and the median for the whole distribution of data fitted exactly with the lower sporal limit (38 µm) following the dichotomous key of the genus (Fig. 4). As occurs with isolate S15, that fact could exclude this strain from the concept of *P. australis* (Ahmed & Cain 1972).

- **S17. Morphotype AM**

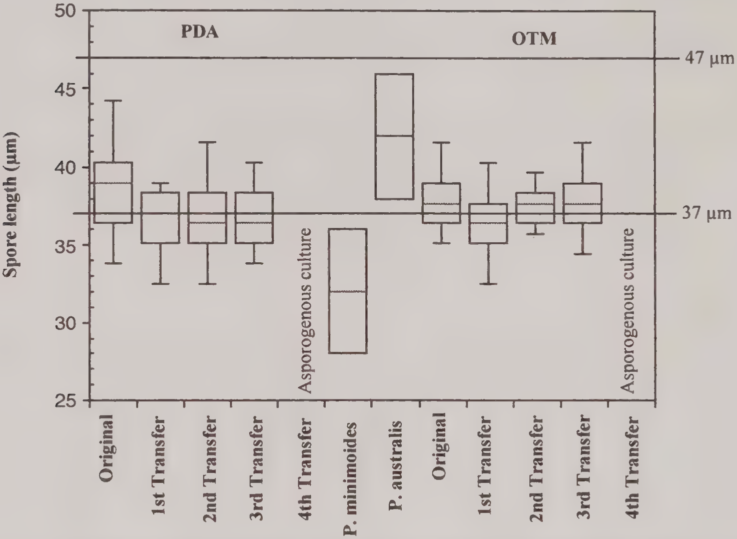

Fig. 4. Spore length of S17 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. australis* and *P. minimoides* are shown in the center of the graph

In isolate S19 (Fig. 5), all the cultures obtained were fertile, so we made 210 spore measurements. This strain was initially identified as *P. similis* (Khan & Cain) Arenal, given the spore size range exhibited by the original cultures (42-52 µm). Although several of the subcultures also fitted with the description of this species, the 4th transfer in both media, as well as the 2nd one in PDA, showed much smaller spores that were consistent with the spore length range of *P. australis*.

The isolate S25 (Fig. 6) was initially identified as *P. minima* based on the distinct morphology of the germ slit, showing a characteristic kink in the middle, although the spores were consistently larger than the margins given for this species. Actually, 71% of the 168 measurements made (two tranfers in PDA were sterile) exceeded the upper limit (32(-34) µm) of *P. minima*, and even the median of the whole data set (36.5 µm) was above that limit. However, in general they were not within the range of *P. australis* either (except for the original culture in PDA and the 2nd subculture in OTM), and, interestingly, the ascospores always showed a characteristic kink in their germ slit. On the other hand, the differences among the different subcultures were also remarkable (see, for instance, the 3rd subculture in PDA and the 2nd transfer in OTM).

- **S19. *P. similis***

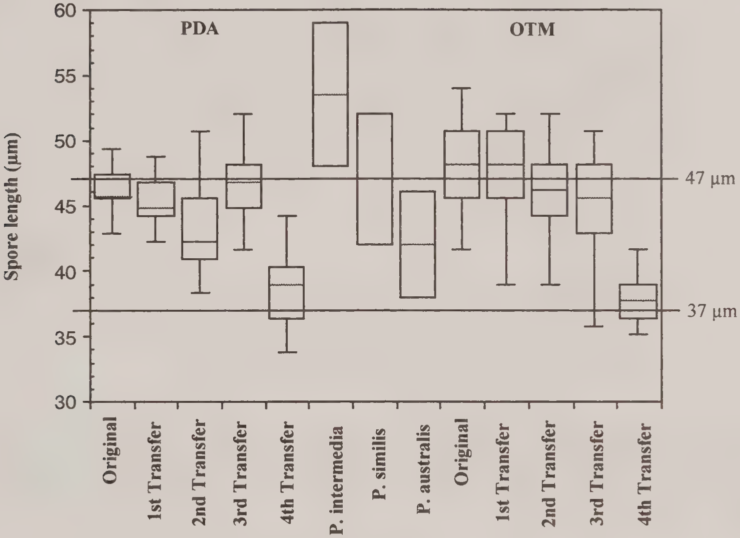

Fig. 5. Spore length of S19 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. intermedia*, *P. similis* and *P. australis* are shown in the center of the graph.

In isolate S34 (Fig. 7), initially determined as *P. australis*, one of the subcultures in PDA and three in OTM were sterile. More than 90% of the 126 ascospores measured were within the range of size described for *P. australis,* and the differences among the subcultures were not as noteworthy as observed for other isolates. However, the germ slit showed a consistent trend to adopt an atypical parallel disposition, quite different from the oblique to diagonal germ slit described for this species (Ahmed & Cain 1972).

All the subcultures obtained from the isolate S35 were fertile (Fig. 8). The isolate was identified as *P. minimoides*, based on the observations made on the first culture obtained in PDA. Although only 18.5% of the spores measured were out of the limits established by Ahmed & Cain (1972), and the median (34 µm) was within those limits (although close to the upper limit), two of the cultures (the original one in OTM and the 2nd transfer in this medium) showed spores with dimensions consistently higher, although too small to be considered *P. australis*.

• S25. Morphotype MiA

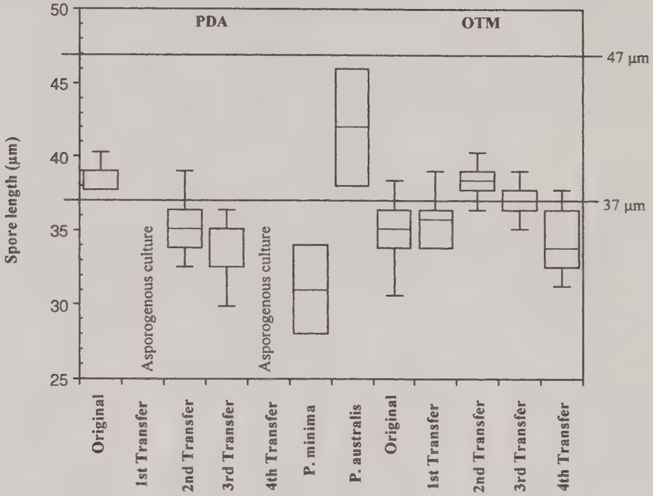

Fig. 6. Spore length of S25 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. minima* and *P. australis* are shown in the center of the graph.

• S34. Morphotype A-P

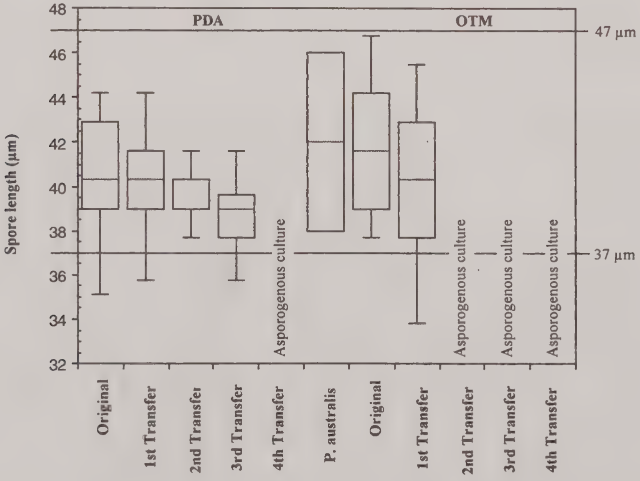

Fig. 7. Spore length of S34 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. australis* is shown in the center of the graph.

• S35. Morphotype ML

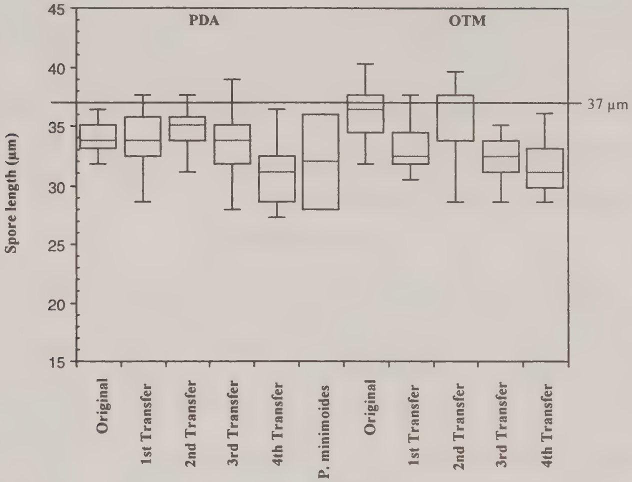

Fig. 8. Spore length of S35 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. minimoides* is shown in the center of the graph.

• S37. *P. grandispora*

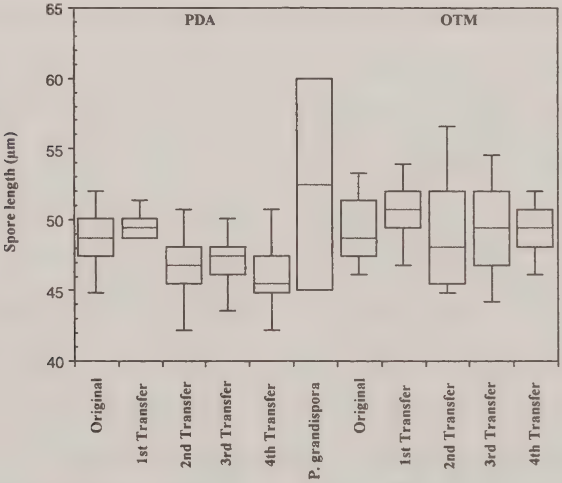

Fig. 9. Spore length of S37 isolate in PDA and OTM media. The spore size range given by Ahmed & Cain (1972) for *P. grandispora* is shown in the center of the graph.

Finally, in the isolate S37 (Fig. 9), identified as *P. grandispora*, more than 90% of the 210 spores measured were within the expected range. The remaining ascospores were always smaller than the lower limit given for the species, and in general all the spores measured were consistently in the lower part of the theoretical distribution, hardly ever surpassing 53 µm. The variation across the subcultures was lower than for other isolates. The spore length range exhibited by this isolate would be also consistent with that of *S. tenuispora* Khan & Cain, a species very close to *P. grandispora*. However, the isolate S37 fits better with the description of *P. grandispora*, based on its broader ascospores and oblique germ slit.

Discussion

The main conclusion of our work is the instability of some morphological features used for the identification of *Preussia* species observed after repeated subculturing. Ascospore length, which is the main character used to distinguish species in the group *P. intermedia/P. australis/P.minimoides*, can vary to such a degree from one subculture to another, that this character alone could induce the same strain to receive different epithets depending on the culture studied. For instance, the isolate S15 could be identified as *P. minimoides* in the original culture in OTM, or as *P. australis*, in the 1st transfer in the same medium (Fig. 3). Likewise, the isolate S19 would be *P. similis* in the original and 1st transfer in OTM, whereas it would fit with *P. australis* in the 2nd and 4th transfers in PDA and the 4th in OTM.

Also, ascospores very frequently exceeded the size limits established in the descriptions given by Ahmed & Cain (1972), or they showed intermediate sizes between the species accepted by these authors. This poses an additional challenge on mycologists, who have to decide on whether to try to adjust their observations to the existing descriptions (expanding the size range originally defined), or to erect a new species when the characters observed cannot be satisfactorily accommodated in any of the already described species, with the risk of populating the genus with new and probably meaningless species. Overall, our data revealed that the limits established to delimit the species concept in the complex *P. intermedia/P. australis/P. minimoides* are ambiguous and should be treated with caution, at the very least.

In this regard, the existence of intermediate forms between *P. australis* and *P. intermedia* was already acknowledged by Kahn & Cain (1979), who erected the species *S. similis* to accommodate strains of *Preussia* with a range of ascospore size in between those two species. The isolate S19 would fit well with the description of *P. similis*, with the caveat that three of the subcultures obtained could be reasonably ascribed to *P. australis* (Fig. 5).

Likewise, we have found at least two isolates (S15 and S17) showing an ascospore size range intermediate between *P. minimoides* and *P. australis*, and another isolate (S25) which was intermediate between *P. minima* and *P. australis*. Whether these isolates represent new species may be debatable. Although we do not feel confident that these isolates should be assigned to a new species, given the variability in characters aforementioned, it is possible that additional data less dependent on morphology (e.g. gene sequencing) could help to clarify this.

This variability has been also reported by other authors for *Preussia* species, although never in studies specifically focused on addressing this point. Thus, Cain (1961) mentioned a broad range of variation with respect to the shape of the asci, the length of the stipe and the arrangement of the asci within the pseudothecium. Moreover, he alluded to the existence of morphological variations referred to a progressive decrease in the number of asci, and an increase in the number of paraphyses, after a few transfers of the cultures. This author suggested lot of caution with respect to making species descriptions and delimitations adequate, mentioning the extensive confusion concerning this genus. Likewise, Bell (1983) reported spore populations of intermediate length between *S. intermedia* and *S. teretispora* S.I. Ahmed & Cain, in specimens collected in New Zealand, alluding also to the instability of the germ slit disposition. Finally, Khan & Cain (1979) reported the size and shape variability in the spores from other *Sporormiella* species (*S. pilosa* (Cain) S.I. Ahmed & Cain and *S. tetramera* S.I. Ahmed & Cain) in specimens collected in South Africa compared with North American isolates, and they mentioned also the length variability in *P. minima*.

Furthermore, we have observed that other diagnostic characters are also very variable in culture, even in the same culture plate. Thus, germ slit positioning with respect to the longitudinal axis of the ascospore was not constant, showing the existence of a continuum between diagonal, oblique or parallel types. The only exception was the existence of the characteristic kink in the germ slit of strains of *P. minima*, which remained constant. Moreover, we have found other strains similar to S25, showing ascospores larger than the typical length assigned to *P. minima*, but in which the germ slit morphology was easily recognizable. Other characters mentioned in the key proposed by Ahmed & Cain (1972), such as the presence or absence of ostiolate ascomata, or different features of the perithecia (pseudothecium) neck, were not constant neither (data not shown). All this makes it very difficult to make an accurate and reliable identification of members of this group of *Preussia* species.

No trends were observed in the variation in spore size across subculturing, i.e, in general we did not find that late subcultures produced consistently either larger or smaller ascospores than the original cultures.

However, asporogenous cultures and abnormal spore sizes (i.e., extreme compared to the rest of subcultures) were relatively more frequent in late transfers than in the earlier ones (see isolates S17, S19 and S34). Likewise, the culture media did not influence the morphology traits addressed in this study, and similar variability was found in either PDA or OTM. When the spore measurements were treated as Q coefficients instead of length, we observed basically the same variability across the transfers, although with a slightly more homogeneous distribution (data not shown), as could be expected from the smaller variation range observable in spore width.

In summary, our work shows a high degree of variability in the characters used to differentiate the species of *Preussia* mentioned. Sometimes, this variability makes the reliable identification of specimens at the species level difficult, and suggests that there needs to be a lot of caution before erecting new species in this group based on a morphology apparently not fitting species that have already been erected. It is however, possible, that the use of molecular techniques (i.e., sequencing of ribosomal DNA or other genes), combined with morphological characters, would facilitate a better understanding of species concept within the genus *Preussia*.

Acknowledgements

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Literature Cited

Ahmed SI, Cain RF. 1972. Revision of the genera *Sporormia* and *Sporormiella*. Canadian Journal of Botany 50: 419-477.

Arx von JA. 1973. Ostiolate and nonostiolate pyrenomycetes. Proceedings Koninklijke Nederlandse Akademie van Wetenschappen, Series C 76: 289-296.

Arx von JA, Aa van der HA. 1987. *Spororminula tenerifae* gen. et sp. nov. Transactions of the British Mycological Society 89: 117-120.

Auerwald B. 1866. In Rabenhorst. *Fungi europaei exsiccatti* No. 921. Hedwigia 5: 189.

Barrasa JM, Checa J. 1991. Dothideales del parque natural de Monfragüe (Cáceres). I. Boletín de la Sociedad Micológica de Madrid 15: 91-102.

Bell A. 1983. Dung fungi. An illustrated guide to coprophilous fungi in New Zealand. Victoria University Press. Private Bag Wellington. Wellington, New Zealand.

Cain RF. 1961. Studies on coprophilous ascomycetes. VII. *Preussia*. Canadian Journal of Botany 39: 1633-1666.

De Notaris G. 1845. Micromycetes Italici novi vel minus cogniti. Mem. Acad. Torino 2: 342.

Ellis JB, Everhart BM. 1892. The North American Pyrenomycetes. Newfield, New Jersey.

Fuckel L. 1866. Fungi rhenani, Suppl. Fasc. 3: 1750.

Guarro J, Abdullah SK, Gené J, Al-Saadoon AH. 1997. A new species of *Preussia* from submerged plant debris. Mycological Research 101: 305-308.

Heinemann P, Rammeloo J. 1985. De la mesure des spores et de son expression. Agarica 6: 366-380.

Khan RS, Cain RF. 1979. The genera *Sporormiella* and *Sporomia* in east Africa. Canadian Journal of Botany 57: 1174-1186.

Korolyova OV. 2000. New ascomycete species *Sporormiella tomilinii* Korolyova. Mycol. and Phytopat. 34: 11-13.

Lorenzo LE. 1994. A new hairy species of *Sporormiella*. Mycological Research 98: 10-12.

Munk A. 1957. Danish Pyrenomycetes. Dansk Botanisk Arkiv 17: 1-491.

Richarson MJ. 2001. Diversity and occurrence of coprophilous fingi. Mycological Research 105: 387-402.

Stolk AC. 1955. *Emericellopsis minima* and *Westerdykella ornata*. Transactions of the British Mycological Society 38: 419-424.

Valldosera M, Guarro J. 1990. Estudios sobre hongos coprófilos aislados en España. XV. El género *Preussia* (*Sporormiella*). Boletín de la Sociedad Micológica de Madrid 14: 81-94.

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Vezdaea rheocarpa new to North America

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Abstract—*Vezdaea rheocarpa* is documented for North America for the first time.

Key words—Lichens, lichenized fungi, Arizona, Vezdaeaceae

Introduction

During an excursion to the San Francisco Mountains, Arizona in June 1998, I collected a small crustose lichen growing on dead or dying bryophytes. A closer examination revealed that it belonged to *Vezdaea rheocarpa* Poelt & Döbbeler. As this species is not included in the North American checklist of lichen forming, lichenicolous and allied fungi (Esslinger 1997) and I have found no other reports of this species from the continent, this represents a first report of *V. rheocarpa* from North America.

The genus *Vezdaea* Tsch-Woess & Poelt currently comprises ten species world-wide. They are rather inconspicuous and difficult to find in the field and our knowledge of the distributon of the different species is probably rather poor. So far only two other species have been found in North America, *V. stipitata* Poelt & Döbbeler and *V. leprosa* (P. James) Vezda (Esslinger 1997, Buck et al. 1999). It is likely that additional records of these species, as well as finds of other species in the genus, will be made. A key to the ten species presently known was published in Giralt et al. (1993).

The species

Vezdaea rheocarpa Poelt & Döbbeler
Lichenologist 1977(9): 170. Typus. Südliches Burgenland, Bergen bei Jennersdorf, über verschiedenen Moosen, 17.3.1974, J. Poelt & P. Döbbeler (GZU-Holotype, LD-Isotype).

The characters of the specimen found agree well with the description of *V. rheocarpa* (Poelt & Döbbeler 1975, see also Coppins 1987) and with isotype-material in LD. The distinctly warted ascospores measure 18–22 x 8–11 µm in the collected specimen. Paraphyses are apparently lacking. The pointed spines are well-developed, *c.* 6–10 µm long, and covers the surface of the goniocysts. The species was found growing on moribound *Hypnum revolutum* in an alpine community close to the timberline (3400–3500 m. alt.), in a northwest-facing slope just below the top of a ridge. Other species collected nearby included *Cetraria ericetorum*, *Lecidoma* *demissa*, *Psoroma hypnorum*, *Fuscopannaria praetermissa* and *Protopannaria pezizoides* (Nash et al 2002).

In Europe, *Vezdaea rheocarpa* grows on mosses and liverworts and has also been found on foliose lichens such as *Nephroma parile* and *Peltigera praetextata*. Like other species in the genus, it is metal tolerant and is known from lead/zinc-contaminated soils and magnesium-rich limestone (Gilbert 1980, 2000).

SPECIMENS EXAMINED -- UNITED STATES. ARIZONA, Coconino Co., San Francisco Mountains, on the ridge running NE from Humphreys Peak, 35°21'N, 111°41'W, *c.* 3400-3500 m. *M. Westberg 858* (LD); **AUSTRIA.** Südliches Burgenland, *J. Poelt & P. Döbbeler* [Poelt, *Lich. Alp.* no. 293] (LD -Isotype).

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Literature cited

Buck WR., Shaw AJ, Piercey-Normore MD, Tabaee A, Antonovics J, Crone EE. 1999. Unusual lichens under electric pylons on zinc-enriched soil. Bryologist 102: 130-132.

Coppins BJ. 1987. The genus *Vezdaea* in the British Isles. Lichenologist 19: 167-176.

Esslinger TL. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University. http//www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (First posted 1 december 1997, most recent update 17 july 2002), Fargo North Dakota.

Gilbert OL. 1980. Effect of land use on terricolous lichens. Lichenologist 12: 117-124.

Gilbert OL. 2000. Lichens. 288 pp. London: Harper Collins Publishers.

Giralt M., Poelt J, Suanjak M. 1993. Die Flechtengattung *Vezdaea* mit *V. cobria* spec. nov. Herzogia 9: 715-724.

Poelt J., Döbbeler P. 1975. Über moosparasitische Arten der Flechtengattung *Micarea* und *Vezdaea*. Bot. Jahrb. Syst. 96: 328-352.

Nash TH III., Ryan BD, Gries C, Bungartz F. (eds) 2002. Lichen Flora of the Greater Sonoran Desert Region I. 532 pp. Arizona State University, Tempe, Arizona, Lichens Unlimited.

MYCOTAXON

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Aspergillus, Penicillium and related species reported from Turkey

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Abstract—This database, available online, reviews 250 published accounts and presents a list of species representing the genera *Aspergillus, Penicillium* and related species in Turkey. *Aspergillus niger, A. flavus, A. fumigatus, A. versicolor* and *Penicillium chrysogenum* are the most common species in Turkey respectively. According to the published records, 365 species have been recorded from various subtrates in Turkey.

Key Words—*Eupenicillium, Gliocladium, Paecilomyces. Talaromyces*

Introduction

Aspergillus and *Penicillium* are economically, ecologically, and medically important and large genera. Species of these genera can cause the decay of stored products. They are important in view of health hazards. In addition, they are used in industrial and food fermentation processes, and they exist commonly in different type of soils, indoor and outdoor air, food and water (Domsch et al. 1980; Klich 1993; Fischer & Dott 2003). Since *Aspergillus* and *Penicillium* are found almost everywhere, they are frequently cited in species lists in ecological studies. Thus accurate identification of *Aspergillus* and *Penicillium* at the species level is essential. *Aspergillus* and *Penicillium* are not easy to identify to the species level. To further complicate things, the taxonomy of both genera still needs work, but there appear to be fewer problems in *Aspergillus* than in *Penicillium.*

More information on the taxonomy of these two genera can be found in many books (e.g., Raper & Thom 1949, Raper & Fennell 1965, Pitt 1979, Domsch et al. 1980, Ramirez 1982, Pitt & Hocking 1985, Samson & Pitt 1990, Singh et al. 1991, Pitt et al. 2000, Samson & Pitt 2000, Klich 2002, Samson et al. 2002), and articles (e.g., Christensen & Backus 1962, Pitt 1973, Klich 1993, Banke et al. 1997, Muntanola-Cvetkovic et al. 2001, Peterson et al. 2001, Tuthill et al. 2001, Tuthill et al. 2002). The recent book by Klich (2002) enables researchers to identify common *Aspergillus* species morphologically.

This *Aspergillus* and *Penicillium* database is significant for international community because the Turkish literature is not available to scientists who live outside the country; moreover, it is published in Turkish journals that are not readily available internationally.

The purpose of this database is to document the *Aspergillus, Penicillium,* and related species isolated from Turkey. The database will make the Turkish literature on the subject available to an international audience. It will also give future researchers information on whether a species is a new record for Turkey.

The online database reviews 250 published materials and presents a list of species isolated from Turkey. The species list for the *Aspergillus* and *Penicillium* species and related genera are arranged in alphabetical order in the website. The first part of this work was published by Asan (2000). But we need to update the species list. Synonyms and authors of fungal names were found in literature such as Samson & Pitt (1990), Pitt et al., (2000), Klich (2002) and www.indexfungorum.org.

The nomenclature follows updates presented in Samson & Gams (1985) and Pitt et al. (2000). Throughout my database, I assume that the authors properly identified the species reported.

There are 365 species which have been isolated and identified from the different regions of Turkey. Asan (2000) gave 251 species in 2000, and this database adds 114 species to the earlier list, bringing the total number of *Penicillium* species isolated in Turkey so far to 199 and of *Aspergillus* species to 116.

Aspergillus niger is the most commonly reported species in Turkey. It has been reported in 124 different studies, with *A. flavus* reported in 100, *A. fumigatus* in 90, *A. versicolor* in 68, *P. chrysogenum* in 65, *A. terreus in* 54, *A. ochraceus* in 51, *P. funiculosum* in 46, *Penicillium glabrum (P. frequentans)* in 44, and *A. wentii* in 41 studies respectively. These species may adapt to ecological conditions better than the other, more rarely reported, species. Species were isolated from different substrates and/or habitats such as, soil, water, air, food, etc. The database contains a summary table of this information by genus.

Literature Cited

Asan A. (2000). Check list of *Aspergillus* and *Penicillium* species reported from Turkey. Turk J Bot 24: 151-167.

Banke S, Frisvad JC, Rosendahl S. (1997). Taxonomy of *Penicillium chrysogenum* and related xerophilic species, based on isozyme analysis. Mycol Res 101: 617-624.

Christensen M, Backus MP. (1962). A new *Penicillium* from coniferous forest soil. Mycologia LIV: 573-577.

Domsch KH, Gams W, Anderson TH. (1980). Compendium of soil fungi. London, Academic press.

Fischer G, Dott W. (2003). Relevance of airborne fungi and their secondary metabolites for environmental, occupational and indoor hygiene. Archives Microbiol 179: 75-82.

Klich MA. (1993). Morphological studies of *Aspergillus* section *Versicolores* and related species. Mycologia 85: 100-107.

Klich MA. (2002). Identification of common *Aspergillus* species. First Ed. 122 pp. Centraalbureau voor Schimmelcultures, Utrecht, The Netherlands.

Muntanola-Cvetkovic M, Hoyo P, Gomez-Bolea A. (2001). *Penicillium aureocephalum* anam. sp nov. Fungal Diversity. 7: 71-79.

Peterson SW, Ito Y, Horn BW, Goto T. (2001). *Aspergillus bombycis*, a new aflatoxigenic species and genetic variation in its sibling species, *A. nomius*. Mycologia 93: 689-703.

Pitt JI. (1973). An appraisal of identification methods for *Penicillium* species: Novel taxonomic criteria based on temperature and water relations. Mycologia 65: 1135-1157.

Pitt JI. (1979). The genus *Penicillium* and its teleomorphic states *Eupenicillium* and *Talaromyces*. 634 pp. Academic Press. Inc. London.

Pitt JI, Hocking AD. (1985). Fungi and food spoilage. Academic Press. London.

Pitt JI, Samson RA, Frisvad JC. (2000). List of accepted species and synonyms in the family *Trichocomaceae*. In: Samson RA, Pitt JI (Eds.). Integration of Modern taxonomic methods for*Penicillium* and *Aspergillus* classification. 510 pp. Singapore: Harwood Academic Publishers, pp. 9-49.

Ramirez C. (1982). Manual and atlas of the *Penicillia*. 874 pp. Elsevier Biomedical. New York and Oxford.

Raper KB, Thom C. (1949). A manual of the *Penicillia*. 875 pp. The Williams & Wilkins Comp. Baltimore.

Raper KB, Fennell DI. (1965). The genus *Aspergillus*. 686 pp. The Williams & Wilkins Comp. Baltimore.

Samson RA, Gams W. (1985). Typification of the species of *Aspergillus* and associated teleomorphs. [In: RA Samson, JI Pitt, (Eds.): Advances in *Penicillium* and *Aspergillus* systematics. pp. 31-54, 483 pp. Plenum Press. New York and London].

Samson RA, Pitt JI (Eds.). (1990). Modern Concepts in *Penicillium* and *Aspergillus* Classification. 478 pp. NATO ASI series. Plenum Press, New York.

Samson RA, Pitt JI (Eds.). (2000). Integration of modern taxonomic methods for *Penicillium* and *Aspergillus* classification. 510 pp. Harwood Academic Publishers. Singapore.

Samson RA, Hoekstra ES, Frisvad JC, Filtenborg O. (2002). Introduction to food- and airborne fungi. Sixth Ed. 389 pp. Centraalbureau Voor Schimmelcultures–Utrecht - The Netherlands.

Singh K, Frisvad JC, Thrane U, Mathur SB. (1991). An illustrated manual on identification of some seed-borne *Aspergilli, Fusaria* and *Penicillia* and their mycotoxins. First Ed. 133 pp. Danish Goverment Inst. Seed Pathol. for Developing Countries. Denmark.

Tuthill DE, Frisvad JC, Christensen M. (2001). Systematics of *Penicillium simplicissimum* based on rDNA sequences, morphology and secondary metabolites. Mycologia 93: 298-308.

Tuthill DE, Frisvad JC. (2002). *Eupenicillium bovifimosum*, a new species from dry cow manure in Wyoming. Mycologia 94: 240-246.

Online Database

The most recent version of the complete database is available online at **<http://www.mycotaxon.com/authors/weblists.html>**

MYCOTAXON

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Interesting Gasteromycetes from Catamarca and La Rioja (Argentina). 1

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Abstract—Nine species of Gasteromycetes belonging to the genera *Chlamydopus, Podaxis* and *Tulostoma* are recorded from the provinces of Catamarca and La Rioja, Argentina. *Podaxis argentinus, Tulostoma beccarianum, T. herteri, T. mohavei, T. obesum, T. pulchellum,* and *T. striatum* are described. Photographs are also provided for the uncommon *T. herteri.*

Key words—chorology, spore ornamentation, SEM, taxonomy

The provinces of Catamarca and La Rioja are located in the Northwest of Argentina, characterized by its rugged terrain. Six phytogeographical provinces are distinguished in these areas, each one determined by the predominance of a different kind of vegetation (Morlans 1995). The samples studied in this paper have been collected from areas with xerophilic vegetation, with *Prosopis spp., Aspidosperma quebracho-blanco* Schltdl., *Acacia aroma* Gillies ex Hook. & Arn., *Larrea divaricata* Cav., *Larrea cuneifolia* Cav., *Geoffroea decorticans* (Gillies ex Hook. & Arn.) Burkart, and several Cactaceae, where some Gasteromycetes, especially members of the families Tulostomataceae and Podaxaceae, can frequently be found.

We have previously published other papers on Gasteromycetes from Catamarca (Dios *et al.* 2000, 2001).

Material and Methods

The studied specimens have been deposited in the herbarium of the "Universidad de Alcalá", Spain (AH), in the herbarium of the "Instituto de Investigación para el Desarrollo Socioeconómico de Los Llanos de La Rioja, Universidad Nacional de La Rioja", Argentina (IZAC), and in the Mª M. Dios´s personal herbarium ("Departamento de Biología, Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Catamarca", Argentina).

The scanning electron microscope (SEM) photographs were made according to Moreno *et al.* (1995).

Chlamydopus meyenianus (Klotzsch) Lloyd, *Mycol. Notes Lloyd Libr. Mus.* 14 (note n° 236). 1903.

Material studied: Catamarca, Pomán Department, Renania farm, roadside, on bare soil, S. Segura, 27-VI-2000, AH 28477 (slides in herb. M.M. Dios n° 69).

This collection consists of only one basidiome, 60 mm high. Spore sac subglobose, 18 x 13 mm. Peridium smooth, cream-coloured. Stoma consisting of an irregular and plane apical thorn. Gleba ferrugineous. Stem 49 x 7 mm, longitudinally striate, rather cylindrical, concolorous with the endoperidium to ochraceous, widened apex up to 11 mm diam. and ending basally in a volviform scaly structure up to 9 mm diam. Spores 5-7 µm diam., globose, yellowish, patently verrucose; under SEM the ornamentation is formed by large verrucae, sometimes arranged as irregular and short crests. Threads of the gleba 3-5 µm diam., hyaline, thin walled, with some fibulated septa. Basidia and basidioles persisting in maturity, subglobose, 5-7 µm diam., grouped in typical fascicles.

Observations: *Chlamydopus meyenianus* is a rare species adapted to arid and semiarid areas, previously cited from Argentina, in the provinces of Catamarca (Spegazzini 1927; Domínguez de Toledo 1989), Mendoza (Spegazzini 1912), Salta, Buenos Aires (Spegazzini 1898), Chubut (Spegazzini 1913), La Rioja and Santiago del Estero (Domínguez de Toledo 1989). A detailed description, including good illustrations of this species, has been recently published by Lunghini (2001).

Recent molecular studies (Martín *et al.* 2000) support placing the genus *Chlamydopus* in the Phelloriniaceae.

Podaxis argentinus Speg., *Anales Mus. Nac. Buenos Aires* 6: 186. 1898 (as *Podaxon*).

= *Podaxon patagonicum* Speg., *Anales Mus. Nac. Buenos Aires* 6: 186. 1898.

Material studied: Catamarca, Ambato Department, La Puerta, east bank of Río del Valle, on bare soil near *Larrea divaricata*, M.M. Dios, 23-IV-1999, AH 28462 (slides in herb. M.M. Dios n°57); Tinogasta Department, Medanitos, roadside, R. Salinas, herb. M.M. Dios n° 67, 68 (duplo in AH 28476). La Rioja, General Ocampo Department, Campo Miraflores, between Milagro and Comandante Leal, on bare soil, F. Biurrum, L. Blanco & T. Flores, 26-III-2002, herb. M.M. Dios n° 95, (duplo in AH 19697).

Observations: The discussion regarding the presence or absence of a germ pore on the spores of *Podaxis argentinus* has been rekindled by Dios *et al.* (2001). The additional collections studied here, which present perfectly mature spores, lead us to reconsider the observations expressed in that study. We have been able to verify with certainty that the spores of this species do not present a small germ pore. However, a remnant of a hilar apiculus in the spores can clearly be observed, whose fragility often makes it appear broken or almost completely removed, leaving a small circular scar. The presence of this circular scar is the reason why several authors have described a small germ pore on the spores of *P. argentinus*, even using SEM.

Podaxis argentinus has been cited from several provinces of Argentina: Mendoza, Salta, Río Negro, Buenos Aires (Spegazzini 1906), Córdoba, (Nouhra & Domínguez de Toledo 1992), Santiago del Estero (Martínez 1971), San Luis (Domínguez de Toledo 1993), and recently from Catamarca (Dios *et al.* 2001). This is the first record from the province of La Rioja.

Tulostoma beccarianum Bres. *in* Petri, *Ann. Mycol.* 2: 413-414. 1904.
= *T. simulans* Lloyd, *The Tylostomeae* p.18. 1906.

Material studied: Catamarca, Pomán Department, gallery forest, on sand and litter of *Mimozyganthus carinatus* (Griseb.) Burkart and *Deuterocohnia longipetala* Mez, M.M. Dios, 30-X-1998, AH 28468 (slides in herb. M.M. Dios n° 73).

Basidiome 27 mm long. Spore sac 8 mm diam., globose to subglobose. Exoperidium indistinct. Endoperidium smooth, whitish, papyraceous. Stoma tubular. Stem 23 x 2 mm, cylindrical, light brown, longitudinally striate, wider at the bulbous base (3 mm diam). Gleba ferrugineous.

Spores 4-4.5 µm diam., globose to subglobose, yellowish, asperulate. Under SEM, the ornamentation is formed by verrucae and short crests. Capillitium 3-4 µm diam., thin walled, hyaline, branched and scarcely septated.

Observations: This species has previously been cited from Argentina: provinces Buenos Aires and Chubut (Wright 1987). This is the first record from Catamarca. The taxonomic position of this species has been treated by Altés & Moreno (1993).

Tulostoma fimbriatum Fr., *Systema Mycologicum* 3: 43. 1829.

Material studied: Catamarca, Capital Department, in garden with *Citrus limon* (L.) Burm.f., R. Ghanem, 10-VIII-1999, AH 28463; *ibidem*, Basural de "La Aguada", roadside, on litter of *Acacia aroma,* M.M. Dios, 7-III-2002, AH 28472 (duplo in herb M.M. Dios n° 77); Ambato Department, La Puerta, on litter of *Schinopsis haenkeana* Engl., *Acacia visco* Lorentz ex Griseb., *Prosopis nigra* Hieron., *Celtis tala* Gillies ex Planch., M.M. Dios, 23-IV-1999, herb. M.M. Dios n° 62; Capayán Department, Concepción, camping area road, on herbaceous and woody litter, M.M. Dios, 7-XI-1999, AH 28464 and herb. M.M. Dios n° 70; *ibidem,* under *Croton sarcopetalus* Müll. Arg. and herbaceous Asteraceae, M.M. Dios, 27-II-2000, AH 28479; *ibidem,* Colonia del Valle, under *Acacia aroma* and *Prosopis nigra,* M.M. Dios, 8-VI-2000, herb. M.M. Dios n° 71; Andalgalá Department, Chaquiago, on woody litter, M.M. Dios & J.M. March, 21-IV-2000, herb. M.M. Dios n° 63; Fray Mamerto Esquiú Department, Sierra Brava, roadside, M.M. Dios, 16-VI-2000, AH 28478; Valle Viejo Department, Vista Larga, on woody litter, A. Zurita, 25-V-2000, AH 28470; Pomán Department, gallery forest, on litter of *Mimozyganthus* carinatus, M.M. Dios, 30-X-1998, AH 19655 (duplo in herb. M.M. Dios n° 64).

Observations: *Tulostoma fimbriatum* is a well characterized species by the presence of a hyphal exoperidium, fimbriate stoma, and verrucose spores (4)4.5-5(5.5) µm diam. in the samples studied. This is one of the most common species of *Tulostoma* in Catamarca, always found in xeric zones, associated with the Chaco Serrano and Chaco Arido vegetation.

Tulostoma fimbriatum has previously been cited from some provinces of Argentina: Salta, Mendoza (Wright 1987), Catamarca (Wright 1987, Dios *et al.* 2000) and Córdoba (Domínguez de Toledo 1989).

Tulostoma herteri Lohwag & F. Swoboda, *Revista Sudamer. Bot.* 1: 3. 1942. (Figs. 1-6)

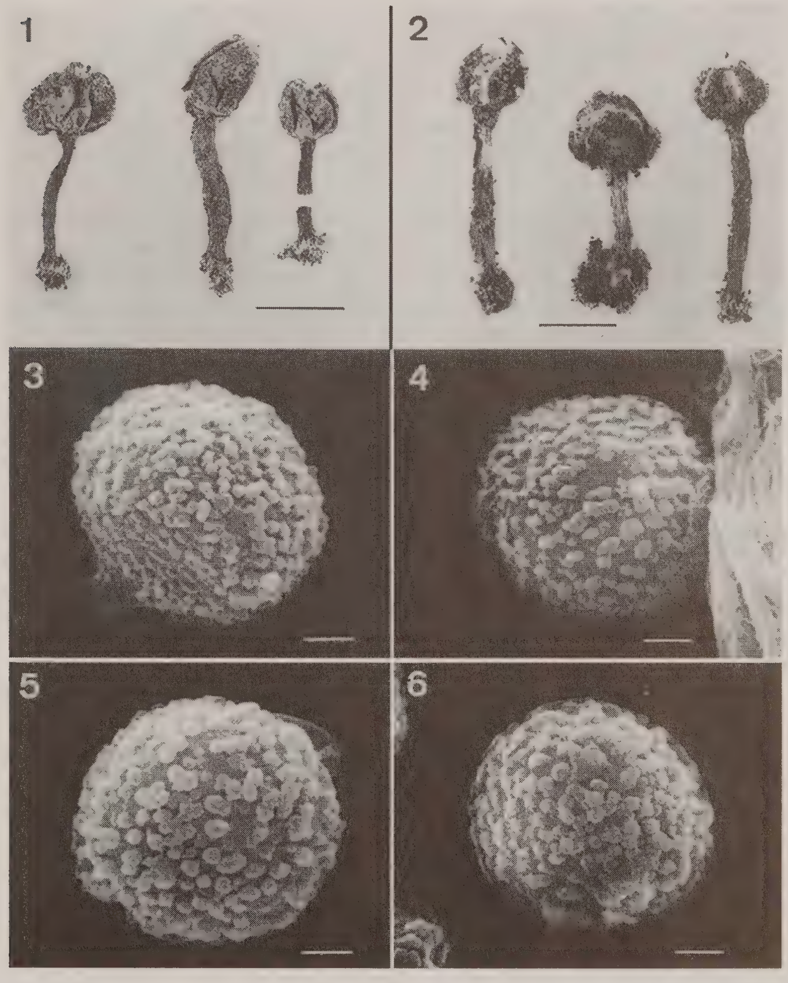
Material studied: Catamarca, Capayán Department, El Milagro, among mosses under *Larrea sp.,* L. Rodriguez, 10-VI-1994, herb. M.M. Dios n° 1 (as *T. berteroanum* (Lév.) De Toni *in* Sacc.); *ibidem,* near Quebrada de la Cébila, humus of *Larrea divaricata,* A. Vedia, 11-II-1995, herb. M.M. Dios n° 12 (as *T. perplexum* Long & S. Ahmad); Valle Viejo Department, Vista Larga, humus of *Larrea sp.,* A. Zurita, 15-XI-2000, AH 19649; *ibidem,* El Portezuelo, La Bajada, among mosses, with, *Aspidosperma quebracho-blanco,* M.M. Dios, 9-VI-2000, AH 19647, 28474, 28475; *ibidem,* among mosses, with *Larrea divaricata,* A. Agüero, 13-VI-2000, AH 19648 (duplo in herb. M.M. Dios n° 73).

Type collections compared: URUGUAY: Cerro de Montevideo, W.G. Herter 81995, 1927, Plantae Uruguayenses Exsiccatae 2184 (FH), holotypus of *Tulostoma herteri.* SOUTH AFRICA: Cape prov., Lockenburg, sandy soil, J.P.H. Acocks 18934, 18-VIII-1956, PREM 41614, holotypus of *Tulostoma gracilipes* J.E. Wright. INDIA: Rohtak, S. Ahmad 338, 15-VI-1941, Herb. Long 10261 (BPI), holotypus of *Tulostoma parvissimum* Long & S. Ahmad. AUSTRALIA: Australia merid., Tapper, PAD, holotypus of *Tulostoma pulchellum* Sacc.

Basidiomes 8-19 mm long (Fig. 2). Spore sac 3-8 mm diam., globose to subglobose. Exoperidium hyphal mixed with small particles of soil, scantily developed but usually persisting on the greater part of the spore sac. Endoperidium smooth, whitish, papyraceous. Stoma fibrillose-fimbriate, concolorous, mammose. Stem 4-15 x 0.8-1 mm, cylindric, covered by a somewhat scaly greyish brown cortex, with a bulbous base 2-3 mm diam. agglomerating sand and mycelium remains. Gleba ochraceous to ferrugineous.

Endoperidium formed by cylindrical to sinuous, thick walled hyphae, 4-8 µm diam., not broadened at the septa. Spores 4-5 µm diam. (up to 5.5 µm in the holotype), globose to subglobose, yellowish, minutely verrucose. Under SEM, the ornamentation is formed by small and numerous verrucae

(Figs 4,6), usually densely arranged, sometimes anastomosed in irregular and short crests. Capillitium 2-5 µm diam., subhyaline, thick-walled, branched, slightly or not broadened at the ochraceous septa (3-6 µm diam).



Figs. 1,3,5. *Tulostoma herteri,* Herter 81995 (FH), holotypus. 1. Basidiomes. 3,5. Spore ornamentation under SEM. **Figs. 2,4.** *Tulostoma herteri,* AH 19647. 2. Basidiocarps. 4. Spore ornamentation under SEM. **Fig. 6.** *Tulostoma herteri,* AH 19648. Spore ornamentation under SEM. Scale bars: 1,2 = 5 mm; 3-6 = 1 µm

Observations: These new Argentinian recollections have allowed us to define better and to check the constancy of the macro- and microscopic characters of this species, little known so far and considered as "not well defined" (Wright 1987). The macro- and microscopic study of the holotype of this species (Figs. 1,3,5) shows a great similarity with the characteristics observed in the Argentinian collections. *Tulostoma herteri* is characterized by its rather small basidiomes, with usually slender and not very well developed stems, the presence of a mammose and fibrillose-fimbriate stoma (it is usually similar to a bryophyte peristoma, as indicated by Wright 1987), the scantly developed hyphal exoperidium, and the spore ornamentation with small, numerous and well defined verrucae.

Some species can be confused with *Tulostoma herteri* because of its similar aspect: *T. gracilipes* J.E. Wright and *T. parvissimum* Long & S. Ahmad. Both of these also possess small basidiomes and fibrillose-fimbriate stoma, although not mammose, and even with tendency to appear indefinite in *T. parvissimum.* Nevertheless, the membranous exoperidium, that is present in these two species, provides a clear difference to *T. herteri.* Another important feature, the spore ornamentation, is also very different in *T. parvissimum*: it consists of more developed, irregular and not well defined crests and verrucae. The spore ornamentation under SEM of *T. gracilipes* is much more similar to that of *T. herteri.*

Another species with certain similarity to *Tulostoma herteri* is *T. pulchellum* Sacc., especially in features such as the type of stoma and the spore ornamentation. But in this case the basidiomes are usually bigger, reaching up to 50 mm long, with a larger spore sac (up to 15 mm diam.), with a typical membranous exoperidium, and larger spores (4.5-6.5 µm diam.) with somewhat broadened and flattened verrucae (Moreno *et al.* 1995).

Tulostoma herteri has been cited from Argentina, Bolivia, Uruguay and the USA (Wright 1987). The only Argentinian records are from the provinces of Santa Cruz (as *T. patagonicum* Speg.) and Tucumán (Wright 1987). After checking the material from the province of Catamarca cited by Dios (1997) as *T. berteroanum* (Lev.) De Toni *in* Sacc. and *T. perplexum* Long & S. Ahmad, it is clear that these collections belong to *T. herteri.* Therefore, *T. perplexum* must be eliminated from the American gasteromycetes catalogue. *Tulostoma herteri* is a new record from Catamarca.

Tulostoma mohavei Lloyd, *Mycol. Notes Lloyd Libr. Mus.* 64: 992-993. 1920.

Material studied: Catamarca, Pomán Department, gallery forest, on humus of *Bulnesia retamo* Griseb., M.M. Dios, 30-X-1998, AH 19656 (duplo in herb. M.M. Dios nº 75); Capayán Department, on humus of *Larrea sp.* and *Cercidium praecox* (Ruíz & Pav.) Harms, M.M. Dios, 19-XI-1993, AH 28487 (slides in herb. M.M. Dios n° 9); *ibidem*, Quebrada de La Cébila, on bare soil, M.M. Dios, 22-III-1995, herb. M.M. Dios n° 10. La Rioja, Chamical Department, Salina La Antigua, under *Prosopis reptans* Benth., F. Biurrun & E. Mercado, 31-V-2000, AH 28469 (duplo in IZAC 6469 bis, and slides in herb. M.M. Dios n° 76).

Basidiomes 24-32 mm long. Spore sac 9-15 mm diam., globose to subglobose. Exoperidium hyphal. Endoperidium smooth, whitish, papyraceous. Stoma tubular. Stem 20-38 x 2-4 mm, cylindrical, light-brown, longitudinally striate. Gleba pale brown to ferrugineous.

Spores 4-5 µm diam., globose to subglobose, smooth, yellowish. Under SEM the spore surface appears asperulate to rugose. Capillitium 2-8 µm diam., hyaline, branched.

Observations: *Tulostoma mohavei* is characterized by the tubular stoma, hyphal exoperidium and asperulate to rugose spores. Other species with similar features, according to Wright (1987), are: *T. amnicola* Long & S. Ahmad, cited from India, *T. brevistipitatum* B. Liu, Z.Y. Li & Du, cited from China, *T. chersonense* Sosin, cited from Ukraine, *T. evanescens* Long & S. Ahmad, cited from India and Argentina, *T. fusipes* Har. & Pat., cited from Africa (Mali), the Middle East (Jordan) and North America (USA), and *T. meristostoma* Long, cited from USA and Argentina. The difficulty to distinguish all these species makes the revision of the type collections necessary, in order to evaluate possible synonymies within the genus. In the meantime, we prefer to use the older epithet for the American material.

Tulostoma mohavei has previously been cited from Catamarca and Mendoza (Wright 1987), thus this is the first record from the province of La Rioja.

Tulostoma obesum Cooke & Ellis, *Grevillea* 6: 82. 1878.
Missapplication: *T. volvulatum sensu* Hollós, *Die Gasteromycetes Ungarns*. 1904.

Material studied: Catamarca, Pomán Department, Campo de Saujil, Bolsón de Pipanaco, on dry soil without vegetation, M.M. Dios, 23-V-2000, AH 19638; ibidem, G. Rodriguez, 3-VI-2000, AH 28460; Capital Department, on dry soil without vegetation, M. Medina, 20-VI-1999, AH 19639 (duplo in herb. M.M. Dios n° 65); *ibidem*, on humus of *Aspidosperma quebracho-blanco* and *Prosopis nigra*, M.M. Dios, 16-XI-1999, AH 19644. La Rioja, Chilecito Department, Sierra de Velasco base (800 m), roadside, under *Sclerophylax sp.*, *Bouteloua barbata* Lag., *Euphorbia sp.*, *Atriplex sp.*, *Trianthema argentina* Hunz. & Cocucci and *Amaranthus sp.*, F. Biurrun, E. Pagliari & R. Gatica, 15-II-2002, AH 28461 (duplo in herb. M.M. Dios n° 66, and IZAC 7027).

Basidiomes 37-95 mm long. Spore sac 12-20 mm diam., globose to subglobose, sometimes dorsiventrally depressed as a result of its fructification in stony areas. Exoperidium slightly membranous to hyphal, usually not very well developed and persisting in the basal half of the spore sac. Endoperidium smooth, whitish to pale brown, papyraceous in mature specimens but very coriaceous when immature. Stoma circular, plane, becoming indefinite and lacerate with age. Gleba dark brown. Stem 30-110 x 3-7(10) mm, whitish to pale brown, cylindric to tortuous, longitudinally striate, and sometimes squamose, ending basally in a volviform structure up to 15 mm diam, some specimens with a well developed mycelial cord.

Spores 4-6 µm diam., globose to subglobose, yellowish, completely smooth both under LM and SEM. Capillitium 4-10 µm diam., thick walled up to 2 µm, with characteristic short lateral branches, and with scarce septa due to their disarticulation.

Observations: *Tulostoma obesum* is a species morphologically very variable, usually robust and large, with plane circular stoma, which easily breaks giving rise to a lacerate tear. The stem is very variable in length and thickness, usually with a well developed volviform structure at the base. The gleba is typically dark chocolate-brown. The spores are subglobose and smooth under SEM. The capillitium is different from other members of this genus, with short branches and with scarce and easily broken septa.

The macroscopic variability and the presence of this species in xeric areas of several continents are the reasons why several authors have described it with different epithets. A study about this problem has been published by Altés *et al.* (1999).

Only two records of this species are known from Argentina, the first from the province Chubut as *Tulostoma volvulatum* var. *elatum* Har. & Pat. (Wright 1987), and the second from the province of Catamarca as *T. volvulatum* I.G. Borshch. (Domínguez de Toledo 1989). The new collections studied here confirm the presence of *T. obesum* in Catamarca, where it seems to be an infrequent species. This is the first record from La Rioja province. The collection AH 28461 is of special interest because it consists of numerous mature basidiomes (14).

Tulostoma pulchellum Sacc., *Bull. Soc. Mycol. France* 5: 118. 1889.

Material studied: Catamarca, Pomán Department, Bolsón de Pipanaco, under *Suaeda divaricata* Moq., G. Rodríguez, 20-X-2000, AH 28480 (slides in herb. M.M. Dios n° 72).

Basidiome 36 mm long. Spore sac 11 mm diam., globose to subglobose. Exoperidium membranous, persisting at the base of the spore sac. Endoperidium smooth, whitish, papyraceous. Stoma fimbriate, mammose. Stem 30 x 3 mm, cylindrical, pale brown, squamose, longitudinally striate. Gleba ferrugineous.

Spores 4-5 µm diam., globose to subglobose, yellowish, verruculose. Under SEM the spore ornamentation appears formed by small verrucae and short crests. Capillitium 5-8 µm diam., thick walled, hyaline, branched and septate.

Observations: *Tulostoma pulchellum* has been previously cited from the province of Tucumán (Wright 1987). Therefore, this is the first record from Catamarca.

Tulostoma striatum G. Cunn., *Proc. Linn. Soc. New South Wales* 50: 255. 1925.

Material studied: Catamarca, Ambato Department, La Puerta, on woody litter of *Schinopsis haenkeana, Acacia visco* and *Prosopis nigra,* M.M. Dios, 23-IV-1999, herb. M.M. Dios nº 58, 59; Capayán Department, Concepción, camping area road, in humus of *Croton sarcopetalus* Müll. Arg., M.M. Dios, 7-XI-1999, AH 28465, 28467; Paclín Depatment, Palo Labrado, on humus and woody litter of *Celtis tala* and *Larrea cuneifolia,* J.M. March, 12-XI-1999, herb. M.M. Dios nº 60; Capital Department, Las Heras camp, on humus, M. Perea, 12-VI-2000, herb. M.M. Dios nº 61; Andalgalá Department, Chaquiago, under *Larrea cuneifolia* and Cactaceae, M.M. Dios & J.M. March, 22-IV-2000, AH 19646.

Basidiomes 22-40 mm long. Spore sac 7-11 mm diam, globose to subglobose, sometimes dorsiventrally depressed. Exoperidium typically membranous, whitish inside and covered by particles of substrate outside, persisting in the lower half of the spore sac. Endoperidium smooth, cream-coloured to pale brown. Stoma fibrillose. Gleba ferrugineous. Stem 9-29 x 1-3 mm, rather short and cylindrical, sometimes tortuous, longitudinally striate, with bulbous base, 2-4 mm diam.

Spores 4-7 µm diam., globose to subglobose, notably striate. Under SEM the spore ornamentation consists of irregular arranged crests, with small verrucae among them. Capillitium 3-7 µm diam., hyaline to yellowish, thick walled, branched, slightly broadened at the scarce coloured septa.

Observations: *Tulostoma striatum* has been cited from several Argentinian provinces: Entre Ríos, Jujuy, Mendoza, Salta and Santa Cruz (Wright 1949, 1987). The studied material represents the first record from Catamarca. This is a widely distributed species in America (Wright 1987), recently cited in Cuba by Moreno *et al.* (2001).

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Literature Cited

Altés A, Moreno G. 1993. *Tulostoma beccarianum* Bresad., the correct name for *T. simulans* Lloyd. Mycotaxon 48: 223-227.

Altés A, Moreno G, Wright JE. 1999. Notes on *Tulostoma volvulatum* and *T. giovanellae*. Mycol. Res. 103: 91-98.

Dios MM. 1997. Los Gasteromycetes de la provincia de Catamarca I. Orden Tulostomatales. Tesis de Licenciatura. Dpto. Biología, Fac. Ciecias Exactas y Naturales, Univ. Nacional de Catamarca, Catamarca, Argentina. 33 pp. (unpubl.).

Dios MM, Moreno G, Altés A. 2001. *Podaxis argentinus* and other species of Podaxaceae from Catamarca, Argentina. Mycotaxon 80: 453-460.

Dios MM, Moreno G, Altés A, D'Angelo MV. 2000. Algunos Gasteromycetes interesantes de Catamarca, Argentina. In: Micologia 2000 (Consiglio, G. *et al.*, eds.): 155-164. Fondazione Centro Studi Micologici dell'A.M.B. Vicenza.

Domínguez de Toledo L. 1989. Contribución al conocimiento de los Gasteromycetes del centro de Argentina. Tesis Doctoral, Universidad Nacional de Córdoba, Córdoba, Argentina. 262 pp. (unpubl.).

Dominguez de Toledo L. 1993. Gasteromycetes (Eumycota) del Centro y Oeste de la Argentina. I. Análisis crítico de los caracteres taxonómicos, clave de los géneros y orden Podaxales. Darwiniana 32: 195-235.

Lunghini D. 2001. *Chlamydopus meyenianus* (Klotzsch) Lloyd (Tulostomatales, Basidiomycota), un fungo di terre lontane. Boll. Assoc. Micol. Ecol. Romana 52-53: 22-29.

Martín MP, Hidalgo E, Altés A, Moreno G. 2000. Phylogenetic relationships in *Phelloriniaceae* (*Basidiomycotina*) based in ITS rDNA sequence analysis. Cryptog. Mycol. 21: 3-12.

Martínez A. 1971. Notas sobre el género *Podaxis* (*Gasteromycetes*) en Argentina. Bol. Soc. Argent. Bot. 14: 73-87.

Moreno G, Altés A, Ochoa C, Wright JE. 1995. Contribution to the study of the Tulostomataceae in Baja California, México. I. Mycologia 87: 96-120.

Moreno G, Kreisel H, Altés A. 2001. Notes on the genus *Tulostoma* in H. Kreisel's Herbarium. Cryptog. Mycol. 22: 57-66.

Morlans MC. 1995. Regiones naturales de Catamarca-provincias geológicas y provincias fitogeográficas. Revista Ciencia y Técn. Univ. Nac. Catamarca 2(2): 1-36.

Nouhra E, Domínguez de Toledo L. 1992. Interacción entre *Podaxis argentinus* (Basidiomycotina) y Sarcophagidae (Diptera). Bol. Soc. Argent. Bot. 28(1-2): 41-45.

Spegazzini C. 1898. Fungi Argentini novi vel critici. Anales Mus. Nac. Buenos Aires 6: 81-367.

Spegazzini C. 1906. Mycetes Argentinenses III. Anales Mus. Nac. Buenos Aires 9: 25-33.

Spegazzini C. 1912. Mycetes Argentinenses VI. Anales Mus. Nac. Hist. Nat. Buenos Aires 23: 1-146.

Spegazzini C. 1913. Mycetes Argentinenses I. Anales Mus. Nac. Hist. Nat. Buenos Aires I. 24: 167-186.

Spegazzini C. 1927. Gasteromycetas Argentinas. Physis (Buenos Aires) 8 (31): 421-435.

Wright JE. 1949. Contribución al catálogo de Gasteromycetes argentinos I. Lilloa 21: 191-224.

Wright JE. 1987. The genus *Tulostoma* (Gasteromycetes). A world monograph. J. Cramer, Berlin-Stuttgart, Germany. 338 pp.

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Proposed list of extinct, rare and/or endangered macrolichens in Wisconsin

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Abstract—We propose that 41 species of macrolichens be listed for rare status in Wisconsin, along with 6 other species we think are now extinct in the state. Almost 60% of the species occur in the northern part of the state. Some of the extinct species occurred in the southern part. The rare and extinct species exist(ed) in 43% of the counties. None of the rare and extinct species are endemic to Wisconsin, and they represent 7% of the total lichen flora of the state. One species was last collected in 1884, but others were collected only recently. Forty-seven percent of the listed species are ranked critically imperiled (S1).

Key words—state ranks, disjunct, distribution, Midwestern states

INTRODUCTION

Wisconsin, the center state of three upper Midwestern United States, has an area comparable to Michigan, but less than Minnesota, and a population density less than midway between the other two states (Table 1). Recently, the lichen flora of the state was published as a result of John W. Thomson's lifetime collecting in the state (Thomson 2003). The total numbers of lichen genera and species are less than the numbers for the neighboring states (Table 1; Fryday et al. 2001; Fryday 2002; Wetmore, unpublished data). The lower number of species for Wisconsin is probably a result of differing collecting intensities rather than biological realities.

Table 1. Numbers of lichen genera, species, and areas and population densities (2000 U. S. Census data) of three upper Midwestern states, in east to west order.

State	Genera	Species	Area (km^2)	Population density (persons/km^2)
Michigan	187	792	147,136	67.6
Wisconsin	164*	662*	140,672	38.1
Minnesota	205	780	206,207	23.9

Includes 16 new genera and 47 new species from the 2002 Tuckerman Workshop (Appendix, Thomson, 2003)

An earlier, unpublished list of rare lichens of Wisconsin listed 290 species (Thomson & Will-Wolf 2000). This list was considered too large and was difficult to use because of identification uncertainties and cross-listings. Both Michigan and Minnesota have lists of rare and endangered macrolichen species: Michigan has an unofficial list with 34 species (Fryday & Wetmore 2002), and Minnesota has an approved list with 17 (including Special Concern species: *www.dnr.state.mn.us/ets/lichens.html*). These numbers vary because the Minnesota list is an official state government list which must be shorter for practical reasons, while the Michigan list is an unofficial list of proposed species. The publication of *Lichens of Wisconsin* facilitated the assembly of a list of rare and endangered lichens for Wisconsin. This paper reports on 41 such species, and an additional 6 species believed to occur no longer in the state.

METHODS

Our approach was similar to Fryday & Wetmore's (2002) in that only macrolichens were considered. Microlichens such as crustose, lichenocolous fungi, and stubble (calicioid) lichens were excluded because they are under-collected by most lichenologists and are often impossible to identify in the field. The authors are aware of several rare crustose species in the state but do not feel confident to report them here until more field work is undertaken.

Specimens at WIS, MIL, MIN, MSC, and F were examined to verify identifications, and label data were compiled. Synonyms were also checked. In addition, the collections on Thomson's dot maps (2003) were tallied along with those from the number of specimens from the other herbaria. Some specimen label data were compared to determine if there was any overlap between specimens. A final total number of specimens was tallied and used for determining state element ranks using the *Wisconsin Natural Heritage Working List* guidelines. The proposed rankings for the species in this paper are listed below and are also available on the web at www.dnr.state.wi.us/org/land/er/working_list/taxalists/key.htm.

SX = Apparently extirpated from the state.

SH = Of historical occurrence in Wisconsin, perhaps having not been verified in the past 20 years, and suspected to be still extant.

S1 = Critically imperiled in Wisconsin because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extirpation from the state.

S2 = Imperiled in Wisconsin because of rarity (6 to 20 occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extirpation from the state.

The distinction between SH and SX on the basis of being collected in the past 20 years or not is not very useful for lichens because there are not that many collectors working in the state and a species could go uncollected for that long very easily. Nevertheless we adhered as much as possible to the state guideline in order for the list to be useful to the state.

For each species, the year of the last collection, the North American distribution based on Brodo et al. (2001) and Thomson (2003), the distribution in Wisconsin (northern (N), central (C), southern (S) or scattered), and the occurrence in Wisconsin in relation to the distribution outside of Wisconsin was tabulated. Most of our nomenclature is based either on Thomson (2003) or Esslinger (1997).

RESULTS

Table 2 lists 41 macrolichen species that we consider rare and 6 thought to be extinct in Wisconsin. Of the 47 total species, 47% are foliose, 45% are fruticose, and the remaining 9% are squamulose.

Table 2. Rare and extinct macrolichens of Wisconsin*

Species	Total number of collections	Last collected	Growth form	North American distribution	WI occurrence	WI distribution	Proposed state rank
Ahtiana aurescens (Tuck.) Thell & Randlane	3	1972	Foliose	NE US	Edge of range	N	SH
Anaptychia setifera Räsänen	5	1996	Foliose	NE US	Edge of range	N	S1
Anzia colpodes (Ach.) Stizenb.	3	1945	Foliose	E US	Edge of range	N	SH
Bryoria capillaris (Ach.) Brodo & D. Hawksw.	2	1987	Fruticose	E & W only	Edge of range	N	S1
Bryoria nadvornikiana (Gyelnik) Brodo & D. Hawksw.	3	2001	Fruticose	E Canada	Edge of range	N	S1
Cetraria arenaria Karnefelt	8	1979	Foliose	E US	In range	Scattered	SH
Cladonia arbuscula (Wallr.) Flotow.	4	1980	Fruticose	NE US	In range	N	SH
Cladonia cornuta (L.) Hoffm.	6	2001	Fruticose	Arctic/ boreal	Edge of range	N	S2
Cladonia decorticata (Flörke) Sprengel	6	1988	Fruticose	Arctic/ boreal	Edge of range	N	S1
Cladonia incrassata Flörke	4	1987	Fruticose	NE US	In range	C & N	S1
Cladonia stygia (Fr.) Ruoss	3	1987	Fruticose	Arctic/ boreal	Edge of range	N	S1
Cladonia sulphurina (Michaux) Fr.	1	1987	Fruticose	E & W only	Edge of range	N	S1
Collema polycarpon Hoffm.	4	1978	Foliose	W US	Edge of range	C & N	SH
Dirinaria frostii (Tuck.) Hale & Culb.	3	1957	Foliose	E US	Edge of range	S central	SH
Evernia prunastri (L.) Ach.	1	1983	Fruticose	E & W only	Disjunct	NE	SH
Fuscopannaria leucophaea (Vahl) P. M. Jørg.	3	1965	Squamulose	E & W only	In range	N	SH
Fuscopannaria leucosticta (Tuck.) P. M. Jørg.	1	1990	Squamulose	SE US	Edge of range	N	S1
Heppia lutosa (Ach.) Nyl.	3	1965 2003	Squamulose	US	In range	S central	S2
Hypogymnia tubulosa (Schaerer) Hav.	4	1987	Foliose	E & W only	Edge of range	N	S1
Leptogium arsenei Sierk	4	1990	Foliose	W US	Disjunct	N	S1
Leptogium teretiusculum (Wallr.) Arnold	2	1992	Foliose	E & W only	Disjunct	N	S1
Menegazzia terebrata (Hoffm.) A. Massal.	4	2002	Foliose	E & W only	Edge of range	N	S1
Nephroma bellum (Sprengel) Tuck.	5	1988	Foliose	E & W only	Edge of range	N	S1
Parmotrema chinense (Osbeck) Hale & Ahti	4	1964	Foliose	MW & W US	Edge of range	C & N	SH
Parmotrema stuppeum (Taylor) Hale	2	1964	Foliose	MW & W US	Disjunct	C & N	SH
Peltigera scabrosa Th. Fr.	1	1987	Foliose	Arctic/ boreal	Edge of range	N	S1

Species	Total number of collections	Last collected	Growth form	North American distribution	WI occurrence	WI distribution	Proposed state rank
Peltigera venosa (L.) Hoffm.	1	1944	Foliose	E & W only	Edge of range	N	SH
Physcia tenella (Scop.) DC.	3	1994	Foliose	E & W only	Disjunct	N	S1
Physciella melanchra (Hue) Essl.	5	1990	Foliose	E US	In range	central	S2
Protopannaria pezizoides (Weber) P. M. Jørg.	4	1974	Squamulose	Arctic/ boreal	Edge of range	S central	SH
Pseudevernia consocians (Vainio) Hale & Culb.	3	1987	Fruticose	E US	Edge of range	N	S1
Pseudocyphellaria crocata (L.) Vainio	4	2002	Foliose	E & W only	Edge of range	N	S1
Ramalina farinacea (L.) Ach.	1	1967	Fruticose	E & W only	Disjunct	central	S1
Ramalina pollinaria (Westr.) Ach.	1	1971	Fruticose	E & W only	Disjunct	NE	SH
Ramalina unifolia J. W. Thomson	4	1990	Fruticose	Central US	Edge of range	N	S1
Solorina saccata (L.) Ach.	5	1965	Foliose	E & W only	In range	C & N	SH
Sticta beauvoisii Delise	6	2002	Foliose	E & W only	Disjunct	C & N	S1
Teloschistes chrysophthalmus (L.) Th. Fr.	3	1893 1999	Fruticose	E US	Edge of range	S central	SH
Usnea ceratina Ach.	18	1992	Fruticose	E & W only	In range	N	S2
Usnea trichodea Ach.	8	1971	Fruticose	E US	Disjunct	N	S2
Extinct							
Cladonia acuminata (Ach.) Norrlin	1	1935	Fruticose	Arctic/ boreal	Edge of range	S central	SX
Ephebe lanata (L.) Vainio	2	1939	Fruticose	E US	In range	C & N	SX
Parmotrema perforatum (Jacq.) A. Massal.	1	1884	Foliose	SE US	Disjunct	S	SX
Usnea angulata Ach.	8	1927	Fruticose	US	In range	central	SX
Usnea longissima Ach.	3	1896	Fruticose	E & W only	Edge of range	N	SX
Usnea rubicunda Stirton	10	1945	Fruticose	E & W only	Disjunct	central	SX

[*] The number of collections column contains the total number of collections known in the herbaria studied. The occurrence of the species within Wisconsin in relation to the North American distribution is listed in the "WI occurrence" column, followed by the distribution within Wisconsin and the proposed state rank.

Their distribution in Wisconsin ranges across the state (Table 3) although over half occur in the northern part. Over half (55%) of the listed species are at the edges of their ranges in Wisconsin, and under one half are either disjuncts or well within their known ranges (21-23% each). None of the species appear to be endemic to the state.

Table 3. Distribution of rare and extinct macrolichens within Wisconsin

Region of Wisconsin	Percent
North	57
Central and northern	15
South central	11
Central	9
Northeast	4
South	2
Scattered	2

Two fifths of the species occur nationally either in the eastern or western United States, followed by another 17% from the eastern U. S. only (Table 4). The arctic boreal elements are only 15% of the list. The remaining 29% occur normally from seven other regions of the country.

Table 4. North American distribution of rare Wisconsin lichens

North American Distribution	Percent
East and west only	38
Eastern United States	17
Arctic/boreal	15
Northeastern United States	9
Midwestern and Western United States	4
Southeastern United States	4
United States	4
Western United States	4
Central United States	2
Eastern Canada	2

Almost half (47%) of the 47 species are considered Critically Imperiled (S1) in the state, and almost one third are considered historical occurrences (SH) (Fig. 1). Thirteen percent are thought to be extinct (SX) and the remaining 9% are imperiled.

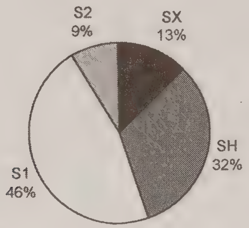

Figure 1. Distribution of state element rankings of 47 rare and extinct Wisconsin macrolichens

One species, *Parmotrema perforatum*, was last collected in 1884, while several species were last collected as recently as 2002 during the Tuckerman Workshop (Thomson 2003).

The 47 extinct and rare Wisconsin macrolichens have been found in 31 of Wisconsin's 72 counties (Fig. 2). Of the 114 species x county occurrences for these species in herbaria, the top 50 (44%) occur in northern counties, with Bayfield having the most. This is primarily due to the high degree of collecting at Apostle Islands National Lakeshore (Wetmore 1988; Wetmore and Bennett 2002). It is also evident that many of the extinct species were found in counties at the southern, central and northwestern parts of the state.

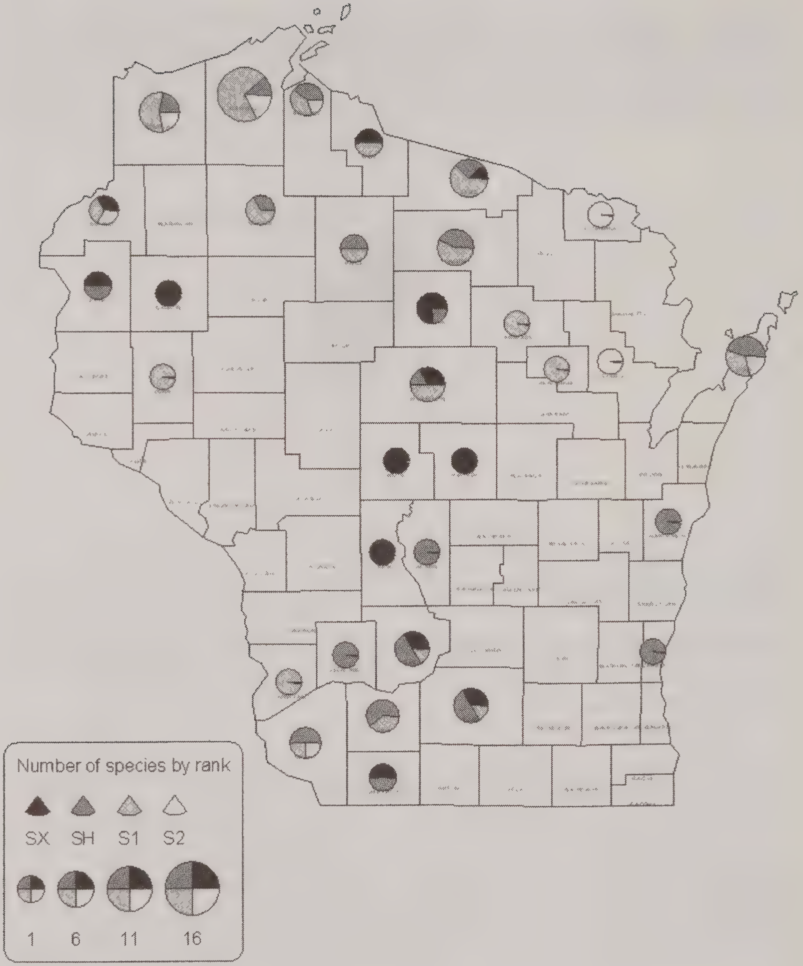
Number of species by rank
SX
SH
S1
S2
1
6
11
16

Figure 2. Number of extinct, rare and endangered lichen species by county

DISCUSSION

Our list for Wisconsin contains seven more species than cited on the Michigan list (Fryday & Wetmore 2002). Seven species are on both lists: *Anzia colpodes, Collema polycarpon, Peltigera scabrosa, Peltigera venosa, Pseudocyphellaria crocata, Ramalina farinacea,* and *Sticta beauvoisii.* Both *Peltigera venosa* and *Pseudocyphellaria crocata* are also on the Minnesota list, as are *Ahtiana aurescens* and *Anaptychia setifera.* This leaves 38 species that are uniquely rare or extinct in Wisconsin and not in the other two states.

The most recent herbarium specimen of one species, *Teloschistes chrysophthalmus,* was collected in 1893. We are aware of a recent collection in Dane County in 1999, but it has not been deposited in a herbarium nor published. The specimen was a very tiny piece (~2 mm), and no other specimens could be found. For these reasons we propose it be given an SH rank instead of extinct, in the hope that it can be located again. Collectors are advised that the species on our proposed list should not be collected but rather be photographed and recorded as sight records so as not to eliminate them.

We are including *Usnea ceratina* even though there are 18 specimens in herbaria because Thomson (2003) states it is very rare in the state. We are proposing that *Usnea rubicunda* be ranked extinct even though Thomson (2003) thought it might still occur in the state. The first author has searched for this species where it was last found and has not been able to find it again.

Three species on the proposed list are also thought to be endangered in Canada: *Fuscopannaria leucosticta, Usnea ceratina,* and *U. rubicunda* (Goward et al. 1998). The usneas are also found in the western U. S., but the *Fuscopannaria* is limited to the eastern U. S.

The authors discovered and collected *Heppia lutosa* in October, 2003 at Sugar Creek State Natural Area, Crawford County, a species that was last collected almost 40 years earlier. This information is not available in Thomson (2003). This species is very small and grows in shady limestone crevices and is easily over-looked. It may occur in other obscure limestone localities in the southern part of the state. Although Brodo et al. (2001) state that this species is very rare and the common species is *H. conchiloba*, we are following Thomson (2003), who synonymized the two species. Our specimens are olive-brown in color, pruinose, and have cortices, which are more consistent with the *H. conchiloba* morphotype. However, no specimens of the genus from the MIN or WIS herbaria were studied by Henssen in her revision of the genus (1994), clouding the picture of this species in Wisconsin. Until this is cleared up in the future this species might be better referred to as *H. lutosa sensu lato*.

The rare lichens of Michigan have their centers of distribution in North America in three areas: northern, eastern, and Appalachian/Great Lakes (Fryday & Wetmore 2002). Wisconsin rare lichens originate from these same areas, but in addition, there are species from the western and southern U. S., probably due to the location of the state being more central than Michigan. This probably explains the small amount of overlap between the two lists. The distributions centers of the rare lichens of Minnesota are comparable to those for Wisconsin.

There are 18 records of extinct species, some from the southern end of the state. All but one of the extinct species occurred in the central or southern parts of the state, implying that extinction of rare species in the central and southern parts is a definite fact. Conversely, over 80% of the records of imperiled or historical records of rare species are from the northern part of the state, suggesting that there is the potential for more extinction to occur there than in the south. However, this observation may be somewhat confounded by the high probability that collecting intensity has been higher in the northern part of the state compared to the southern part. Even though the southern part is more developed, collecting should still continue in some areas. The northern part is more at risk at this time from logging and development impacts. Among the three states, only Minnesota grants legal protection to lichens in the form of a state approved list. Michigan and Wisconsin do not yet have official lists.

The geographic distribution of these 47 species in Fig. 2 may be influenced by several factors. First, some of the northern, central and southwestern areas may show occurrences because of the collecting activities of Hale, Culberson, Thomson and others. Not all parts of the state have been equally sampled. Second, some of the pattern may follow the Wisconsin River valley because there are more natural area remnants along that feature. Much of the rest of the state is in agriculture or forestry.

The number of endangered lichen species represent 4, 7 and 2% of the total number of lichen species in Michigan, Wisconsin and Minnesota, respectively. These percentages would be double if just the macrolichens were used in the calculations, based on the assumption that macrolichens are usually about half of the total number of species. These percentages are all comparable, and even though the species themselves are different in each state (small amount of overlap), it suggests that rarity in these states is less than 10% of the total floras. This compares favorably with 3% for British Columbia (Goward 1996), 9% for Maine (Hinds & Hinds 1998; based on half of the 18% they give for the macrolichens alone in their Table 1). The slightly higher rarity factor for Wisconsin may be an artifact resulting from the generally higher collecting activities in the other two states.

Wisconsin probably has other potentially rare, endangered and/or extinct macrolichen species. Several others have been suggested but our investigations of these have not led to a high degree of certainty about their status. Obviously more work is needed on more species to increase our knowledge. The species proposed in this study should be regarded as the minimum for listing and protection.

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LITERATURE CITED

Brodo IM, Sharnoff SD, Sharnoff S. 2001. Lichens of North America. Yale University Press. 795 pp.

Esslinger TL. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (First Posted 1 December 1997, Most Recent Update 17 July 2002), Fargo, North Dakota.

Fryday AM. 2002. New lichen records from Michigan and other changes affecting Michigan species. Mich. Botanist 41: 85-88.

Fryday, AM, Wetmore CM. 2002. Proposed list of rare and/or endangered lichens in Michigan. Mich. Botanist 41: 89-93.

Fryday AM, Fair JB, Googe MS, Johnson AJ, Bunting EA, Prather LA. 2001. Checklist of lichens and allied fungi of Michigan. Contr. Univ. Michigan Herb. 23: 145-223.

Goward T. 1996. Lichens of British Columbia: Rare Species and Priorities for Inventory. Res. Br., B.C. Min. For. And Hab. Protect. Br., B. C. Min. Environ., Lands and Parks, Victoria, B.C. Work Pap. 08/1996.

Goward T, Brodo IM, Clayden SR. 1998. Rare Lichens of Canada, A Review and Provisional Listing. Committee on the Status of Endangered Wildlife in Canada, Canadian Wildlife Service, Environment Canada, Ottawa, Ontario. 74 pp.

Henssen A. 1994. Contribution to the morphology and species delimitation in *Heppia sensu stricto* (lichenized Ascomycotina). Acta Botanica Fennica 150: 57-73.

Hinds JW, Hinds PL. 1998. An annotated checklist of Maine macrolichens. Pp. 345-376 in Lichenographia Thomsoniana: North American Lichenology in Honor of John W. Thomson. Glenn, MG, Harris, RC, Dirig, R, Cole, MS. eds. Mycotaxon Ltd., Ithaca, NY.

Thomson JW. 2003. Lichens of Wisconsin. Wisconsin State Herbarium, Madison, WI. 386 pp.

Thomson JW, Will-Wolf S. 2000. Rare lichens of Wisconsin. http://www.botany.wisc.edu/wislichens/LichenINTRO.htm.

Wetmore CM. 1988. Lichens and air quality on Apostle Islands National Lakeshore. Final report submitted to National Park Service.

Wetmore CM, Bennett JP. 2002. 2001 lichen studies in Apostle Islands National Lakeshore. Final report submitted to National Park Service.

Wisconsin Natural Heritage Program, Bureau of Endangered Resources. Wisconsin Natural Heritage Working List. Department of Natural Resources, Box 7921, Madison, WI 53707.

MYCOTAXON

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Biogeography and hosts of poroid wood decay fungi in North Carolina: species of *Phellinus* and *Schizopora*

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Abstract—Distribution and host plants in North Carolina are given for 21 species of *Phellinus* and three species of *Schizopora*. A county distribution map is provided for each species. *Phellinus johnsonianus, P. linteus* and *P. melleoporus* and *Schizopora flavipora* are reported for the first time in North Carolina. Numerous new fungus-host plant associations are reported. Species checklists and figures can be accessed at:
http://www.cals.ncsu.edu/plantpath/Personnel/Faculty/Grand/mycotaxon_1.pdf

Keywords—fungus distribution, polypores

Introduction

The importance of fungal biodiversity in ecosystems is well-documented (Lodge 1996, Molina et al. 2001, Rossman & Farr 1997). Recent studies have emphasized fungal biodiversity in unique ecosystems and within unique geographical areas (Esqueda et al. 2003, Gilbertoni & Calvacanti 2003, Keller & Skrabal 2002, Mueller & Mata 2001, Riccardi & Bashore 2003, Rossman et al. 1998). Such studies provide a basic foundation of data that can aid future researchers in knowing what species of fungi are present as well as their distribution within defined areas.

The diversity of ecosystems in North Carolina is reflected by its diversity of flora (Kartesz 1999, Pittillo et al. 1998, Radford et al. 1968). The diversity of woody plant species allows for an equally diverse and large number of poroid wood-decay fungi.

Previous studies (Grand & Vernia 2002, Grand & Vernia 2003, Jung 1987, Vernia & Grand 2000) have reported species of fungi, chiefly poroid wood decay species, from a variety of sites in North Carolina. These studies (Grand & Vernia 2002, Vernià & Grand 2000) addressed new geographical occurrences and new host-plant combinations in North Carolina and the United States and emphasized the need for providing host and distributional data for this important group of fungi. Distributions of *Phellinus* and *Schizopora* in the Southeast by state were reported by Farr et al. 1989, Grand et al. 1976, Gilbertson & Ryvarden 1987, Larsen & Cobb-Poulle 1990, Lowe 1966, Lowe & Gilbertson 1961, and Overholts 1953.

This is the first of a series of papers that provides data on species, host plants and distribution of poroid wood decay fungi in North Carolina.

Materials and Methods

Intensive collecting was done in North Carolina over the past six years (1997-2003). Additional collections in the Mycological Herbarium, Department of Plant Pathology, North Carolina State University (NCU) were examined and records of the Plant Disease and Insect Clinic, Department of Plant Pathology, NCSU were utilized in the results. Previous studies (Grand et al. 1975, Jung 1987) that contained information on specific county locations of poroid wood-decay species were used in developing the distribution maps. Likewise, data from the BPI website (Farr et al. n.d.) provided some county data.

Collections were made of all uncommon species of *Phellinus* and *Schizopora,* unusual forms of these species and species occurring on new or unusual hosts. Specimens were placed in paper bags in the field usually with a sample of decayed wood and appropriate field notes. Specimens were examined in the laboratory and identified using existing taxonomic treatments (Breitenbach & Kraenzlin 1986, Gilbertson & Ryvarden 1986, 1987, Jung 1987, Larsen & Cobb-Poulle 1990, Lowe 1966, Lowe & Gilbertson 1961, Overholts 1953). Collections of *Schizopora apacheriensis* (Gilb. & Canf.) Gilb. & Ryvarden and *S. flavipora* (Cooke) Ryvarden were compared to type specimens (BPI #0237818 and #0239985). Nomenclature and authorities are from Gilbertson & Ryvarden (1986, 1987) and Kirk & Ansell (1992) for the fungi and Kartesz & Kartesz (1980) for the host plant species.

The majority of collection sites were in state parks, game lands and natural areas, Nantahala, Pisgah, Croatan and Uwharrie National Forests, the Blue Ridge Parkway and the Great Smoky Mountains National Park. Counties collected in are shown in Fig. 1. A county distribution map is provided for each species (Figs. 2-25).

Results and Discussion

Twenty-one species of *Phellinus* were found on 56 host species. *Phellinus gilvus* (Schwein.:Fr.) Pat. is the most wide-spread species with *P. gilvus* and *P. contiguus* (Fr.) Pat. reported on the greatest number of host species. *Phellinus johnsonianus* (Murrill) Ryvarden, *P. linteus* (Berk. & M.A. Curtis) Teng and *P. melleoporus* (Murrill) Ryvarden are reported for the first time in North Carolina. All three of these species were previously reported from the Gulf Coast region with *P. johnsonianus* ranging into northeastern United States through the Mississippi River Valley.

All three species of *Schizopora* reported in the United States (Gilbertson & Ryvarden 1987) were found on 41 host species. *Schizopora paradoxa* (Fr.) Donk was the most widespread and most frequently encountered species of *Schizopora*. *Schizopora flavipora* is reported for the first time in North Carolina. *Schizopora apacheriensis* is reported on 20 host species which represents a substantial increase from the 11 hosts reported by Farr *et al*. (1989). *Schizopora apacheriensis* was only recently reported in North Carolina for the first time on *Carpinus caroliniana* Walt. (Grand & Vernia 2002). This study substantially increases the geographic and host species ranges of *S. apacheriensis*. Gilbertson & Ryvarden (1987) indicated this species occurs in Arizona and the Gulf Coast region and contend that it has often been confused with *S. paradoxa*. Likewise, the relatively widespread occurrence of *S. flavipora* in North Carolina (Fig. 24) substantiates the statement by Gilbertson & Ryvarden (1987) that *S. flavipora* also is often confused with *S. paradoxa* and that the geographical range of *S. flavipora* is unclear.

Checklists for the species and maps of the species distributions within North Carolina can be found at:

http://www.cals.ncsu.edu/plantpath/Personnel/Faculty/Grand/mycotaxon_1.pdf

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Literature Cited

Breitenbach J, Kraenzlin F, eds. 1986. Fungi of Switzerland. Vol. 2: Non-gilled fungi. Verlag Mykologia, Lucerne. 412 pp.

Cordell CE & Astin Jr. JS. 1965. A new host for *Fomes annosus*, *Polyporus schweinitzii*, and *Fomes pini*. Plant Dis. Reptr. 49:360.

Esqueda M, Herrerea T, Perez-Silva E, Sanchez A. 2003. Distribution of *Geastrum* species from some priority regions for conservation of biodiversity of Sonora, Mexico. Mycotaxon 87:445-456.

Farr DF, Rossman AY, Palm ME, McCray EB. (n.d.) Fungal Databases, Systematic Botany & Mycology Laboratory, ARS, USDA. Retrieved October 4, 2003, from http://nt.ars-grin.gov/fungaldatabases/

Gibertoni TB, deQ. Calvacanti MA. 2003. A Mycologica survey of the Aphyllophorales (Basidiomycotina) of the Atlantic rain forest in the state of Pernambuco, Braxil. Mycotaxon 87:203-212.

Gilbertson RL, Ryvarden L. 1986. North American Polypores. Vol. 1 *Abortiporus - Lindtneria*. Fungiflora, Oslo. Pp. 1-433.

Gilbertson RL, Ryvarden L. 1987. North American Polypores. Vol. 2 *Megasporoporia - Wrightoporia*. Fungiflora, Oslo. Pp. 437-885.

Grand LF, Menge JA, Bond JJ. 1976. Partial checklist of fungi from Highlands, North Carolina and vicinity. J. Elisha Mitchell Sci. Soc. 91:221-229.

Grand LF, Vernia CS. 2002. New taxa and hosts of poroid wood-decay fungi in North Carolina. Castanea. 67:193-200.

Grand LF, Vernia CS. 2003. Noteworthy Collections, North Carolina, *Cryptoporus volvatus* (Peck) Shear. Castanea. 68:88-89.

Jung HS. 1987. Wood-rotting Aphyllophorales of the southern Appalachian spruce-fir forest. Bibl. Mycol. 119:1-260.

Kartesz JT, Kartesz R. 1980. A synonymized checklist of the vascular flora of the United States, Canada, and Greenland. University of North Carolina Press, Chapel Hill. 688 pp.

Kartesz JT. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. In: Kartesz, J.T., and C.A. Meacham. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Keller HW, Skrabal M. 2002. Discovery of a new tree canopy myxomycete in the Great Smoky Mountains National Park. Inoculum, Suppl. to Mycologia 53(2):1-4.

Kirk PM, Ansell AE. 1992. Authors of fungal names. A list of authors of scientific names of fungi with recommended standard forms of their names, including abbreviations. Index of Fungi Supplement. CAB International, Kew, Surrey, Great Britain. 95 p.

Larsen MJ, Cobb-Poulle LA. 1990. *Phellinus* (Hymenochaetaceae). A survey of the world taxa. Syn. Fung. 3:1-206.

Lodge DJ. 1996. Fungi of Puerto Rico and the United States Virgin Islands: A history of previous surveys, current status, and the future. Annals New York Acad. Sci. 76:123-129.

Lombard FF, Larsen MJ. 1985. *Phellinus bicuspidatus* (Hymenochaetales, Hymnochaetaceae) a new species associated with a white sap rot of oak in Louisiana. Mycologia 77:55-61.

Lowe JL. 1966. Polyporaceae of North America. The genus Poria. State Univ. N.Y. Coll. For. Tech. Publ. 90:1-183 pp.

Lowe JL, Gilbertson R. 1961. Synopsis of the Polyporaceae of the Southeastern United States. J. Elisha Mitchell Sci. Soc. 77:43-61.

Molina R, Pilz D, Smith J, Dunham S, Dreisbach T, O'Dell T, Castellano M. 2001. Conservation and management of forest fungi in the Pacific Northwestern United States: an integrated ecosystem approach, 19-63. In: Moore D, Nautra MM, Evans SE, and Rotheroe M, eds. Fungal Conservation Issues and Solutions. Cambridge Univ. Press, New York. 262 pp.

Mueller GM, Mata M. 2001. The Costa Rican national fungal inventory: a large-scale collaborative project. Inoculum, Suppl. to Mycologia 52(5):1-4.

Overholts LO. 1953. The Polyporaceae of the United States, Alaska and Canada. University of Michigan Press, Ann Arbor. 466 pp.

Pittillo JD, Hatcher Jr. RD, Buol SW. 1998. Introduction to the environment and vegetation of the southern Blue Ridge Province. Castanea 63:202-216.

Radford AE, Ahles HE, Bell CR. 1968. Manual of the Vascular Flora of the Carolinas. University of North Carolina Press, Chapel Hill.

Riccardi C, and Bashore S. 2003. First checklist of macrofungi for the Deep Woods all taxa biodiversity inventory, Hocking County, Ohio. Mycotaxon. 86:205-210.

Rosenthal GA. 1963. A new host of *Fomes everhartii.* Plant Dis. 47:152.

Rossman AY, Farr DF. 1997. Toward a virtual reality for plant associated fungi in the United States and Canada. Biodiversity and Conservation 6:739-751.

Rossman AY, Tulloss RE, O'Dell TE and Thorn RG. 1998. Protocols for an all taxa biodiversity inventory of fungi in a Costa Rican conservation area. Parkway Publications, Inc., Boone, North Carolina. 163 pp.

Vernia CS, Grand LF. 2000. Polypores of a North Carolina Piedmont forest. Mycotaxon 74:153-159.

Wolf FA, Garren KH, Miller JK. 1938. Fungi of the Duke Forest and their relation to forest pathology. Bull. School Forest. Duke Univ. 2:1-122.

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First record of *Scytinopogon* from Mexico, with notes on its systematics

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Abstract—The first report of *Scytinopogon* from Mexico is presented. Descriptions of Mexican material of *S. pallescens* and *S. robustus* are included, and the nomenclature of the described species is discussed along with the systematic and phylogenetic affinities of the genus.

Keywords—Aphyllophorales, taxonomy, tropical mycobiota, clavarioids

Introduction

Scytinopogon Singer is a genus of no more than eight described species with a fundamentally tropical distribution. It was segregated from *Lachnocladium* by Singer (1945) based on the presence of sub–fleshy basidiomata, and verrucose–echinulate, sub–angulate yellow spores. The genus is distinguished from other similar genera such as *Pterula* by the consistency of its basidiomata and the color of its spores. Singer (1945) designated *Pterula pallescens* Bres. [≡ *Lachnocladium pallescens* (Bres.) Bres.] as the type species. The etymology of the name *Scytinopogon* refers to its macromorphological resemblance to leather barbs (Donk 1954).

The genus *Scytinopogon* has been included in the past in several families — Clavariaceae (Corner 1970), Thelephoraceae (Donk 1964), Gomphaceae (Maas Geesteranus 1963) and Scytinopogaceae (Jülich 1981) — and has been linked to a variety of genera — *Cristella, Trechispora* (Jülich 1981, Larsson 1992), *Hydnodon* (Corner 1970, Maas Geesteranus 1963, Reid 1971), *Bankera* (Corner 1970, Maas Geesteranus 1963, Reid 1971), *Phellodon* (Corner 1970), *Polyozellus* (Corner 1950), *Thelephora* (Corner 1950, Donk 1964), *Ramariopsis* and *Clavulinopsis* (Corner 1970).

In the Americas *Scytinopogon* has been reported from Bolivia, Brazil, Panama, Puerto Rico, the United States, Uruguay, and Venezuela (Corner 1950, 1970; Petersen 1988a; Reid 1965; Singer 1945), as well as in Asia, Africa Australia, and New Zealand (Corner 1970, Petersen 1988b).

There are few reports of clavarioid Aphyllophorales in Mexico (see García–Sandoval et al. 2002, Villareal & Pérez–Moreno 1991), or these fungi are occasionally found in general species lists (García–Romero et al. 1970, Varela & Cifuentes 1979). The objective of this study is to present the first report of *Scytinopogon* Singer in Mexico and discuss the systematics of this genus.

Methods

A revision was made of the mycological collections of the following herbaria: Facultad de Ciencias, UNAM (FCME), Escuela Nacional de Ciencias Biológicas del Intituto Politécnico Nacional (ENCB), Herbario Nacional de México, Instituto de Biología, UNAM (MEXU), and Universidad Autónoma de Tlaxcala (TLMX). Taxonomic determination of the material was corroborated using the monographic works of Corner (1950, 1970) and Petersen (1988b) as well as additional selected descriptions (Coker 1923; Petersen 1984, 1988a). Microscopic observations were realized using standard mycological techniques (Cifuentes et al. 1986, Largent et al. 1980). Herbaria acronyms were assigned following Holmgren & Holmgren (1995) and Holmgren et al. (1990).

Taxonomic Descriptions

Scytinopogon pallescens (Bres.) Singer. 1945. Lloydia 8: 139.
≡ *Pterula pallescens* Bres. 1899. Bull. Soc. R. Bot. Belg. 38: 157.
≡ *Lachnocladium pallescens* (Bres.) Bres. 1915. Hedwigia 56: 304.
= *Thelephora dewevrei* Bres. 1899. Bull. Soc. R. Bot. Belg. 38: 156.
= *Thelephora serrei* Pat. & Har. 1906. Bull. Soc. Mycol. Fr. 22: 116.
= *Thelephora lactea* Pat. 1923. Bull. Soc. Mycol. Fr. 39: 47.
= *Clavaria durbana* Vand der Byl. 1932. S. Afr. J. Sci. 29: 322.

Plate 1: Figs. **a**, and **b**

Basidiome: size up to 140 mm in length, very branched, white to cream, generally branched from the base, then the stipe poorly differentiated, smooth to subtomentose in this area. **Branches:** dichotomous or polytomous, flattened, glabrous; internodes irregular in length but diminishing gradually towards the apex; rounded axils; apex subcristate to flattened–palmate.

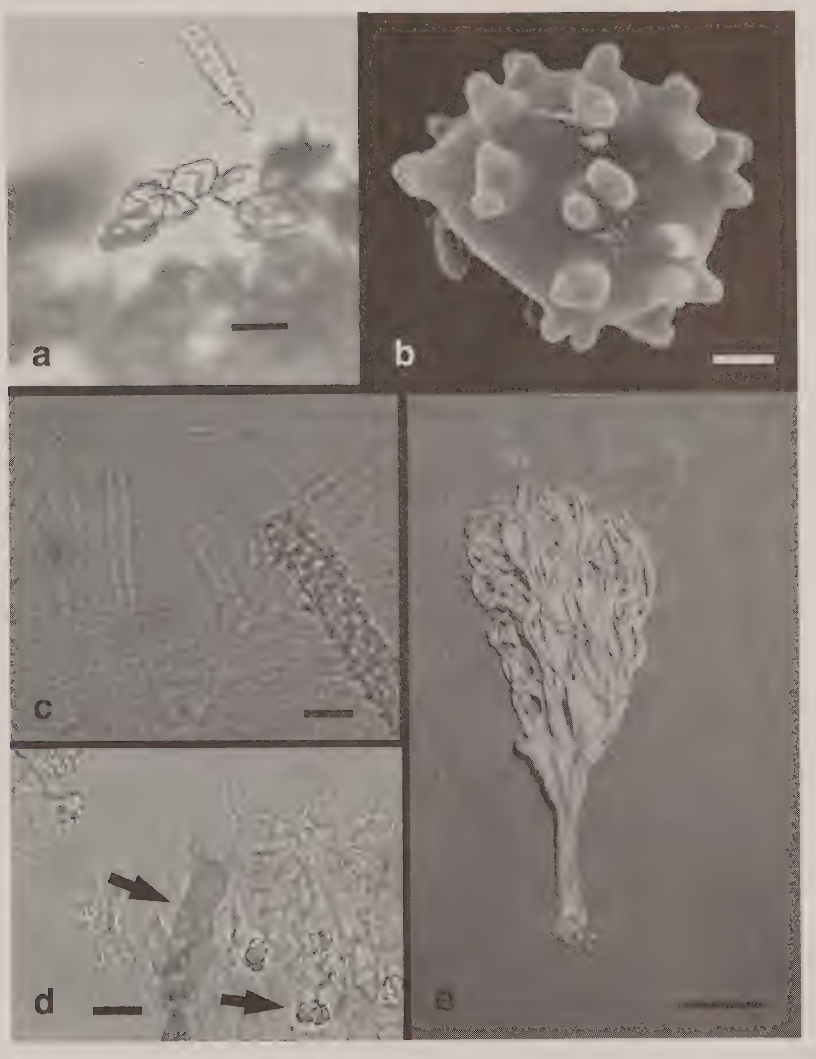

Plate 1. a) Irregularly–shaped crystals in the mycelial hyphae at the base of the stipe of *Scytinopogon pallescens;* **b)** Scanning electron micrograph of the spores of *S. pallescens* showing characteristic ornamentation and shape; **c)** Hyphae with irregularly–shaped crystals in the mycelial hyphae at the base of the stipe in *Scytinopogon robustus;* **d)** Basidia and basidiospore of *S. robustus;* **e)** Dried basidiome of *S. robustus*. Scale bars: a = 10 µm; b-c = 1 µm; d = 5 µm; e = 1 cm. Photographs a, c-e: R. García–Sandoval; b M. Villegas.

Mycelium: at the base of the stipe whitish. **Context:** coriaceous–fibrous to coriaceous, whitish. **Taste and odor:** not clearly distinguishable. **Context:** monomitic, with thin–walled hyaline generative hyphae 1.4 to 3.5µm wide, scarcely clamped **Mycelial hyphae:** at the base of the stipe have thick and irregularly–shaped crystals (Figure a), rare inflated–like septa. **Hymenium:** thickening. **Basidia:** subcylindrical to clavate, bisporic to tetrasporic, the majority tetrasporic. **Basidiospores:** hyaline, 4.2–5.6 x 2.8–4.2µm, subglobose to broadly ellipsoid, with nodular–echinulate ornamentation, then with an angular–cuspidate to irregular elliptical appearance under light microscopy (LM), positive reaction to cotton blue (cyanophilous); hilar appendix not clearly evident, conical; under scanning electron microscopy basidiospores were observed from elliptical to subangulate, with tuberculate–nodulate ornamentation, generally grouped in pairs (Figure b); hilar appendix rounded with an acuminate base.

Habitat: terrestrial, gregarious. In Mexico this taxon has only been collected from secondary vegetation (Acahual) at an altitude of 15 masl.

> **SPECIMEN EXAMINED. MEXICO. OAXACA: Mpio. Chiltepec**, Tuxtepec. 12.X.1967 *Martínez–C.* (ENCB)

COMMENTS. The pattern of basidiospore ornamentation exhibited by this species seems to correspond to the ornamentation of paired spines reported by Petersen (1988a) in *Scytinopogon dealbatus* (Rick) Corner. During the examination of the Mexican specimen, it was possible to observe a structure similar to inflated septa in the mycelium at the base of the stipe; these septa have been reported for the genus *Trechispora,* and is the basis for a postulated relationship between the two genera (Jülich 1981, Larsson 1992). These septa were not observed in the mycelial cords due to the poorly preserved state of the Mexican specimen, and its presence was only corroborated in the mycelia at the base of the stipe.

This species was considered by Corner (1950) as a synonym of *Clavaria angulispora* Pat. [≡ *Scytinopogon angulisporus* (Pat.) Corner]. Because the name *C. angulispora* is older, it has priority over the name *Pterula pallescens* Bres. — in consequence, *Scytinopogon* Singer should be typified by *Clavaria angulispora* instead of *P. pallescens* as originally proposed. However, Petersen (1988b) had revised the type of *Clavaria angulispora,* and concluded that it belongs to the genus *Clavulina* (tentatively *Clavulina connata* Corner), thus removing this taxon from *Scytinopogon* and leaving the genus with the type originally assigned by Singer (1945). Three varieties of *Scytinopogon angulisporus* were described by Corner (1950): *S. angulisporus* var. *curtus* Corner, *S. angulisporus* var.*parvus* Corner, and *S.*

angulisporus var. *gracilis* Corner. Currently, the types of these varieties have not yet been re-examined to corroborate their generic status. Additionally, a number of specimens have been reported as *Clavaria angulispora* (for example Coker 1923) in the literature, but according with description and photographs seem to correspond to *Scytinopogon*. The status of these specimens deserve to be addressed.

Scytinopogon robustus (Rick) Corner. 1970. Beih. Nova Hedwigia 33: 91.
≡*Clavaria robusta* Rick. 1931. Egatea 16: 120.

Plate 1: Figs. **c-d**

Basidiome: up to 50 mm in length in dried material, very branched, completely white when fresh to cream colored in herbarium material; mycelial cords white and delicate at the base. **Stipe:** differentiated, 15–25 x 3–5 mm, flat, smooth to subtomentose. **Branches:** dichotomous or polytomous, flattened, glabrous to subtomentose towards the internal parts; internodes irregular in length though diminishing gradually towards the apex; axils subacute; apex subcristate to flattened–palmate. **Context:** coriaceous–fibrous to coriaceous, whitish. **Taste and odour:** not clearly distinguishable. **Mycelium:** forming monomitic mycelial cords, with uninflated and abundant simple clamp connections. Mycelial hyphae at the base of the stipe of two types: with swollen walls with small, elongated crystals, or naked with only slightly swollen walls (Figure c). **Context:** of the stipe and branches monomitic, with hyaline thin-walled generative hyphae, scarcely clamped, inflated 2.8–19.6 µm wide, slightly dextrinoid. **Hymenium:** slightly thickening. Basidia subcylindrical to clavate, bisporic or tetrasporic, the majority tetrasporic. **Basidiospores:** hyaline, 4.2–5.6 x 2.8–4.2 µm, seen under light microscopy (LM) to have angular–cuspidate to irregular elliptical appearance; nodular echinulate ornamentation; positive reaction to cotton blue (cyanophilous); hilar appendix poorly evident, conical (Figure d).

Habitat: humicolous, gregarious. In Mexico only collected in deciduous forest at an altitude of 1500 masl.

SPECIMEN EXAMINED. **MEXICO. HIDALGO: Mpio. Molango**, Laguna de Atezca. 9.VII.1980 *Cifuentes J. 676* (FCME 1201).

COMMENTS. Of the currently recognized species, only this species and *Scytinopogon echinosporus* (Berk. & Broome) Corner have inflated hyphae and spores larger than 5 µm. Even so, the latter species presents basidiomata with apex light brown and smaller spores (4.5–5.5 x 3.5 µm). This species seems to be well delimited and the combination of diagnostic characters distinguishes it from another species leaves no doubt about its generic affinities.

Comments and Conclusions

This study constitutes the first report of *Scytinopogon* in Mexico. The distribution of the genus in the Americas seems to be limited to tropical zones or localities with warm climates, with its northern limit in the southeastern United States.

The number of species in this genus is still uncertain. The proposed names include *Scytinopogon dealbatus, S. echinosporus, S. robustus, S. pallescens, S. chartaceum* (Pat.) R.H. Petersen, *S. papillosus* Corner, and *S. scaber* (Berk. & M.A. Curtis) D.A. Reid, but several of these names have been proposed as synonyms and a complete monographic treatment of the genus is still necessary.

The phylogenetic affinities of *Scytinopogon* are ambiguous. The phylogeny of the clavarioid Aphyllophorales should be contextualized within the efforts to elucidate the phylogeny of the Homobasidiomycetes (Binder & Hibbett 2002, Hibbett & Thorn 2001, Pine et al. 1999) due to the polyphyletic nature of the group. In the absence of formal phylogenetic studies for *Scytinopogon,* only a few preliminary hypotheses can be offered. A phylogenetic analysis of *Ramariopsis* (García–Sandoval, unpublished data) included four species of this genus and seems to confirm the close relationship between *Scytinopogon* and *Ramariopsis* as proposed by Corner (1970). This is at least partially sustained by the positive cyanophilous reaction of the spores, a character shared by the family Gomphaceae (Villegas et al. 1999); this conclusion cannot be seen as definitive given that the principal objective of the above work was not elucidate the affinities of *Scytinopogon*. Other important hypotheses include the proposed relationship with *Hydnodon* (Corner 1970, Maas Geesteranus 1963, Reid 1971) based on the presence of crystals in the hyphal mycelia at the base of the stalk, the form of the ornamentation of the spores (see figure a-c) and the positive cyanophilous reaction of the spores. The relationship with *Trechispora* (Jülich 1981, Larsson 1992) is supported by the positive cyanophilous reaction of the spores, the form of the spores, and the presence of inflated septa. Among these characters, the positive cyanophilous reaction of the spores has been of phylogenetic use in other groups of the Aphyllophorales (Villegas et al. 1999), but its utility in this case remains to be evaluated.

The evaluation of the affinities of *Scytinopogon* necessarily requires that the majority of the hypotheses previously postulated be taken into account in the context of the phylogeny of the Homobasidiomyecetes.

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Literature Cited

Binder M, Hibbett DS. 2002. Higher-level phylogenetic relationships of Homobasidiomycetes (mushroom-forming fungi) inferred from four rDNA regions. Mol. Phylog. Evol. 22: 76–90.

Cifuentes J, Villegas M, Pérez–Ramírez L. 1986. Hongos. Pages 30–55 in Manual de herbario (Lot A, Chiang F, eds.). Consejo Nacional de la Flora, México DF.

Coker WC. 1923. The clavarias of United States and Canada. The University of North Carolina Press, North Carolina.

Corner EJH. 1950. A monograph of *Clavaria* and allied genera. J. Cramer, Stuttgart Germany.

Corner EJH. 1970. Suplement to "A monograph of *Clavaria* and allied genera". J. Cramer, Stuttgart Germany.

Donk MA. 1954. The generic names proposed for Hymenomycetes — III. “Clavariaceae”. Reinwardtia 2: 441–493.

Donk MA. 1964. A conspectus of the families of Aphyllophoralles. Persoonia 3: 199–324.

García-Romero L, Guzmán G, Herrera T. 1970. Especies de macromicetos citados de México. I. Ascomycetes, Tremellales y Aphyllophorales. Bol. Soc. Mex. Mic. 4: 54-76.

García-Sandoval R, Villegas M, Cifuentes J. 2002. New records of *Ramariopsis* from Mexico. Mycotaxon 82: 323-333.

Hibbett DS, Thorn RG. 2001. Homobasidiomycetes. Pages 121-168 *in* The Mycota VII. Systematics and Evolution. Part B (McLaughlin DL, McLaughlin EG, Lemke PA, eds.). Springer, Berlin.

Holmgren PK, Holmgren NH. 1995. Additions to index herbariorum (Herbaria), 8th ed, 4th series. Taxon 44: 251–266.

Holmgren PK, Holmgren NH, Barnett LC, 1990. Index herbariorum. Part I. The Herbaria of the World. 8th ed. Regnum Veg. 120: 1–693.

Jülich W. 1981. Higer taxa of the Basidiomycetes. J. Cramer, Leiden.

Largent D, Johnson D, Watling R. 1980. How to identify mushrooms to genus III: Microscopic features. Mad River Press, Eureka.

Larsson KH. 1992. The genus *Trechispora* (Corticiaceae, Basidiomycetes). Dissertation. University of Götenborg, Sweden.

Maas Geesteranus RA. 1963. Hyphal structures in Hydnums. Proc. K. Ned. Akad. Wet. Ser. C. 67: 144–156.

Pine EM, Hibbett DS, Donoghue MJ. 1999. Phylogenetic relationships of cantharelloid and clavarioid Homobasidiomycetes based on mitocondrial and nuclear rDNA sequences. Mycologia 91: 944–963.

Petersen RH. 1984. Type studies in the clavarioid fungi VIII. Persoonia 12: 225–237.

Petersen RH. 1988a. Notes on clavarioid fungi. XXII. Three interesting South American collections. Mycologia 80: 571–576.

Petersen RH. 1988b. The clavarioid fungi of the New Zealand. Science Information Publishing Centre, Wellington.

Reid DA. 1965. A monograph of stipitate steroid fungi. Beih. Nova Hedwigia 18: 1-382.

Reid DA. 1971. Intermediate generic complexes between the Thelephoraceae and other families. Pages 331–334 *in* Evolution in the higher Basidiomycetes (R. H. Petersen, ed.) University of Tennessee Press, Knoxville.

Singer R. 1945. New genera of fungi — II. Lloydia 8: 138–144.

Varela L, Cifuentes J. 1979. Distribución de algunos macromicetos en el Norte del Estado de Hidalgo. Bol. Soc. Mex. Mic. 13: 75-88.

Villareal L, Pérez-Moreno J. 1991. The clavarioid fungi from Mexico, I. Addition of the genera *Macrotyphula* and *Typhula*. Micol. Neotrop. Apl. 4: 119–126.

Villegas M, DeLuna E, Cifuentes J, Estrada–Torres A. 1999. Phylogenetic analysis in Gomphaceae *sensu lato* (Basidiomycetes). Mycotaxon 70: 127–147.

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New species of *Asterina* in HMAS, China

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Abstract—*Asterina champereiicola* parasitic on *Champereia manillana*, *A. hainanensis* parasitic on *Microdesmis casearifolia*, *A. malloti-apelti* parasitic on *Mallotus apelta*, and *A. sawadai* parasitic on *Capparis kikuchii* are described and illustrated as new species.

Key words—*Asterinaceae, Capparaceae, Euphorbiaceae, Opiliaceae, Pandaceae*

Introduction

A recent critical restudy of specimens deposited in the Herbarium Mycologicum Instituti Microbiologici, Academiae Siniae (HMAS), China shows that at least four separate taxa of the genus *Asterina* occurring in Taiwan and Hainan, China are at present incorrectly assigned. They are here described and illustrated as new species.

Asterina champereiicola B. Song & T. H. Li, *sp. nov.* Fig. 1

Similis Asterina cansjericola sed differt appressoriis minoribus (9-10 X 5-6 μm) et 5% alternatis; et a A. cansjericola var. indica differt ascosporis echinatiis.
Etymology*: champereiicola, in reference to the host, Champereia manillana.*

Colonies amphigenous, mostly hypophyllous, black, thin to nearly dense, arachnoid or nearly velvety, up to 4 mm in diameter, rarely confluent. Hyphae brown, nearly straight or sinuous, opposite branching acutely or obtusely, loosely or closely reticulate, cells mostly 16-30 X 5.5-7 μm. Appressoria unicellular, opposite or 5% alternate, spreading, straight or nearly bent, ovate or conoid, nearly acute at apex, entire, 9-10 X 5-6 μm. Ascomata lax aggregate to scattered, black, orbicular or hemispherical, up to 150 μm in diameter, no hole or stellulately dehiscent at centre, irregularly crenate to shortly tasseled at periphery, surface cells 2-3 μm wide. Ascospores oblong, brown, 1-septate, obtuse, constricted at septum, echinulate, 23-24 X 9-10 μm.

Holotype: *On leaves of Champereia manillana Merr. (Opiliaceae). Chishui, Taizhong, Taiwan Province, China. Nov. 29. 1928, K. Sawada, HMAS 05100.*

The new species is closely related to *Asterina cansjericola* Hansf. & Thirum. and *A. cansjericola* var. *indica* Hosag., N. P. Balakr. & Goos. *A. cansjericola* is differentiated by having larger (12-16 X 6-8 μm) appressoria of which 5% are opposite while *A.*

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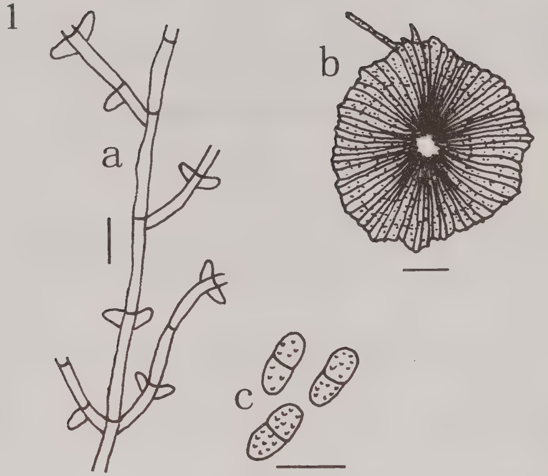


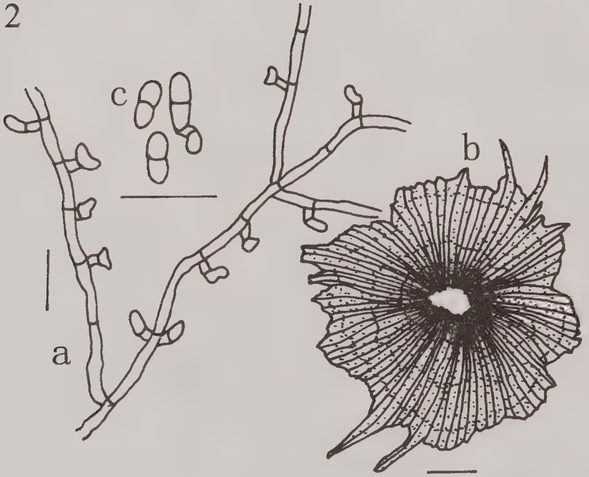


Fig.1 *Asterina champereiicola* (a. hyphae with appressoria; b. ascomata; c. ascospores) (Bars=25µm).
Fig.2 *Asterina hainanensis* (a.hyphae with appressoria; b. ascomata; c. ascospores and one germinating ascospore) (Bars=25µm).

cansjericola var. *indica* is distinguished by smooth ascospores (Hansford &Thirumalachar 1948; Hosagoudar et al. 1996). The newly named *A. champereiicola* also resembles *A. decipiens* Syd. & P. Syd. (distinguished by alternate—or at least not opposite, smaller—7-9 X 3-4 µm— appressoria; see Sydow & Sydow 1912) and (ii) *A. elmeri* Syd. & P. Syd. (with smooth, larger ascospores, 25-30 X 10-14 µm; see Sydow & Sydow 1911). In addition, *A. champereiae* Hansf. produces bicellular appressoria and smooth, smaller (14-16 X 12-14 µm) ascospores (Hansford 1949).

The new species was found mixed with *Meliola champereiae* Syd. & P. Syd.

Asterina hainanensis B. Song, *sp. nov.*

Fig. 2

> *Similis Asterina manihotis sed differt ascosporis minoribus (14-15 X 5.5-6.5 µm) et appressoriis grandioribus (12-17 µm); et a A. punctiformis differt ascosporis minoribus.*
> Etymology: *hainanensis*, in reference to the type locality, the Hainan Province.

Colonies amphigenous, mostly hypophyllous, black, thin, arachnoid or nearly velvety, up to 6 mm in diameter, mostly confluent. Hyphae brown, sinuous or nearly straight, branching opposite, acutely or obtusely, loosely reticulate, cells mostly 20-30 X 5-6.5 µm. Appressoria bicellular, alternate or unilateral, 2% opposite, spreading, straight or nearly straight, 12-17 µm long; stalk cells cuneate or cylindrical, 3-5 µm long; head cells cylindrical, entire or nearly lobate and angulose, 9-12 X 4.5-5.5 µm. Ascomata scattered, black, orbicular to hemispherical, up to 160 µm in diameter, stellulately dehiscing at the centre, irregularly crenate to short tasseled at periphery, surface cells 2.5-3.5 µm wide. Ascospores nearly oblong, brown, 1-septate, obtuse, constricted at septum, smooth, 14-15 X 5.5-6.5 µm.

> **Holotype:** *On leaves of Microdesmis casearifolia Planch. (Pandaceae). Xinglong, Hainan Province, China. July 3, 1956, G.J. Jiang and S.J. Han, HMAS 33464.*

The new species is closely related to *Asterina manihotis* Syd., parasitic on *Manihot*, from Sierra Leone and *A. punctiformis* Lév., parasitic on *Conceveiba*, from Java (Sydow 1939; Stevens & Ryan 1939). The main distinguishing characters of *A. manihotis* are that ascospores are slightly larger (17-20 X 8.5-10 µm), and the appressoria are smaller (6-8 X 4-5 µm). The main distinguishing characters of *A. punctiformis* are that the its ascospores are larger (22-26 X 10-12 µm). The new species is also closely related to *Asterina tragiae* S. Hughes, parasitic on *Tragia*, from the Gold Coast (Hughes 1952), but which differs in having verrucose and larger ascospores (16-19 X 8-9 µm). In addition, the appressoria of these three species all are alternate, not opposite, allowing easy distinction from the new species.

Sydow & Sydow (1914) reported *Asterinella ramuligera* Syd. & P. Syd., parasitic on *Microdesmis casearifolia* Planch ex Hook., from the Philippines; Ryan (Stevens & Ryan 1939) combined it as *Prillieuxina ramuligera* (Syd. & P. Syd.) Ryan; Petrak (1947) recombined it as *Asterina ramuligera* (Syd. & P. Syd.) Petr. The main distinguishing characters of *Asterina ramuligera* are that the ascospores are verrucose and larger (20-26 X 10-12 µm), and the appressoria are longer (20-30 µm) (Sydow & Sydow 1914; Hosagoudar & Abraham 2000), distinguishing these it from the new species.

Asterina malloti-apelti B. Song, *sp. nov.*

Fig. 3

> *Similis Asterina fraseriana sed differt ascosporis laevis et minoribus (17-20 X 7.5-9 µm); et a A. malloti differt ascosporis minoribus et cellulis apicalis clavatis vel suboblongiis.*
> *Etymology: malloti-apelti, in reference to the host, Mallotus apelta.*

Colonies amphigenous, mostly epihyllous, black, thin, arachnoid or nearly velvety, up to 5 mm in diameter, mostly confluent. Hyphae brown, nearly straight to sinuous, irregularly branching acutely or obtusely, loosely reticulate, cells mostly 20-30 X 3.5-4.5 µm. Appressoria bicellular, alternate or unilateral, spreading, bent or nearly straight, 10-17 µm long; stalk cells cuneate to cylindrical, 2-3 µm long; head cells clavate to nearly oblong, entire or sometime nearly lobed, 8-14 X 4-7 µm. Ascomata scattered, black, orbicular to hemispherical, up to 120 µm in diameter, stellulately dehisced at the centre, irregularly crenate to short tasseled at periphery, surface cells 2-3 µm wide. Ascospores oblong, brown, 1-septate, obtuse, constricted at septum, smooth, 17-20 X 7.5-9 µm.

> **Holotype:** *On leaves of Mallotus apelta Muell.-Arg. (Euphorbiaceae). Xinglong, Hainan Province, China. July 3, 1956, S.J. Han, HMAS 33462.*

Up to now, two species of the genus *Asterina*, *Asterina malloti* Sawada & W. Yamam. and *A. malloticola* Hosag., M. Kamarudeen & G. Rajkumar, are recorded as occurring on *Mallotus*, but both those species have larger ascospores (former for 22-27 X 10-12 µm and later for 19-23 X 11-13 µm) and that *A. malloticola* have verrucose ascospores (Yamamoto 1959; Hosagoudar *et al.* 2003). The new species is closely related to *Asterina fraseriana* Syd., parasitic on *Claoxylon,* from New South Wales (Australia) (Sydow 1937). The main distinguishing characters of *A. fraseriana* are larger, verrucose ascospores that are larger (21-24 X 10.5-12 µm). The new species is also closely related to *Asterina scaberrima* Syd., parasitic on *Mareya* from Sierra Leone, but which differs from *A. malloti-apelti* in having nearly globose (6-8 X 5-7 µm), entire appressoria, and broader, verrucose ascospores (19-22 X 10-12 µm) (Sydow 1938).

This species was also found mixed with *Asteridiella malloticola* (W. Yamam.) Hansf.

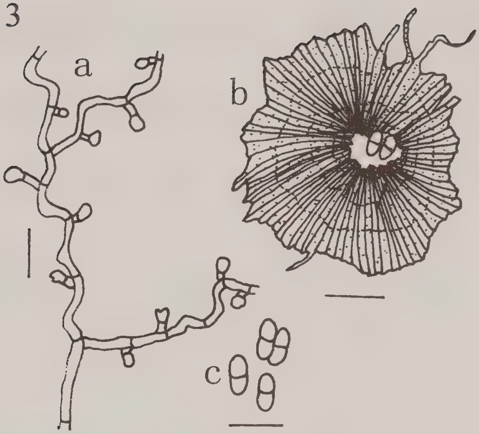
Asterina sawadai B. Song, *sp. nov*

=*Asterina koshunensis* Sawada, Rep. Gov. Res. Inst. Formosa 87:5. 1944, not validly published. Fig. 4

> *Similis Asterina capparidicola sed differt ascosporis longioribus (29-33 X 11-13.5 µm), appressoriis minoribus (6-9 X 5-6 µm); et a A. capparidis differt ascosporis echinulatis et grandioribus, appressoriis minoribus.*
> Etymology: *this species is named in honour of the Kaneyoshi Sawada, collector of the type, a mycologist of Japan, for his outstanding contributions to study on the fungi.*

Colonies amphigenous, black, thin, arachnoid or nearly velvety, up to 4 mm in diameter, mostly confluent. Hyphae brown, nearly straight to sinuous, oppositely branching acutely or obtusely, loosely reticulate, cells mostly 15-23 X 5.3-6.8 µm. Appressoria unicellular, opposite or 20% alternate, spreading, straight or bent, ovate or nearly conoid, entire, 6-9 X 5-6 µm. Ascomata scattered, black, orbicular to hemispherical, up to 230µm in diameter, stellulately dehisced at the centre,

3



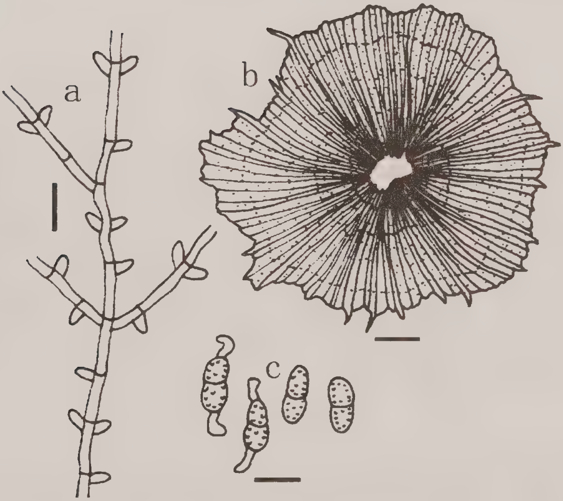


Fig.3 *Asterina malloti-apelti* (a. hyphae with appressoria; b. ascomata; c. ascospores) (Bars = 25 µm).
Fig.4 *Asterina sawadai* (a. hyphae with appressoria; b. ascomata; c. ascospores and germinating ascospores) (Bars = 25 µm).

irregularly crenate to short tasseled at periphery, surface cells 2-3 µm wide. Ascospores oblong, brown, 1-septate, obtuse, constricted at septum, echinulate, 29-33 X 11-13.5 µm.

> **Holotype:** *On leaves of Capparis kikuchii Hay.(Capparaceae). Taidong, Taiwan Province, China. April 27, 1909, K. Sawada, HMAS 05098.*

Asterina koshunensis Sawada was published in 1944 without a Latin description, and thus the name is invalid [Art. 36.1 of C. B. N.].

The new species is closely related to *Asterina capparidicola* Doidge from Africa, but which has shorter and wider ascospores (22-27.5 X 12.5-15 µm), and larger appressoria (10-15 X 5.5-7.5 µm for the head cells) (Doidge 1942). The new species is also closely related to *Asterina capparidis* Syd. & P. Syd. & E. J. Butler (1911) from the India, Madras, and the Philippines, but that species has smooth, smaller ascospores (17-18.5 X 6-7 µm), and slightly larger appressoria (6-12.5 X 6-9.5 µm for the head cells). These species are all parasitic on species of *Capparis*, and their appressoria all are bicellular, allowing easy distinction from the new species. In addition, the new species is also close to *Asterina stixis* B. Song, T.H. Li & Hosag., but which differs in having thin hyphae (3-4 µm), smaller ascospores (20-27.5 X 7.5-14 µm), and appressoria 1-2-lobate (Song et al. 2003).

It was found mixed with the *Meliola sawadai* B. Song.

Acknowledgments

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References

Doidge EM. 1942. A revision of the South Africa *Microthyriaceae*. Bothalia 4:273-420

Hansford CG, Thirumalachar MJ. 1948. Fungi of South India. Farlowia 3:285-314.

Hansford CG. 1949. Tropical fungi 3. New species and revisions. Proc. Linn. Soc. Lond. 160:116-153.

Hosagoudar VB, Balakrishnan NP, Goos RD. 1996. Some *Asterina* species from Southern India. Mycotaxon 59:167-187.

Hosagoudar VB, Abraham TK. 2000. A list of *Asterina* Lev. species based on the literature. J. Econ. Taxon. Bot. 24:557-587.

Hosagoudar VB, Agarwal DK. 2003. Studies on foliicolous fungi-9. Indian Phytopath. 56:98-101

Hughes SJ. 1952. Fungi from the Gold Coast 1. Mycol. Pap. 48:1-91.

Sawada K.1944. Descriptive catalogue of the Formosan fungi 10. Rep. Gout. Kes. Inst. Formosa 87:1-96.

Sawada K. 1959. Descriptive catalogue of Taiwan (Formosan) fungi 11. in Imazeki R., Hiratsuka N. and Asuyama H (ed). Spec. Publ. Coll. Agr. Nat. Coll. Taiwan Univ. 8:1-268.

Song B, Li TH, Hosagoudar VB. 2003. Four new *Asterina* species from Yunnan, China. Fungal Diversity 14:159-166.

Stevens FL, Ryan MH. 1939. The *Microthyriaceae*. Illinois Biol. Monographs 17:1-138. The University of Illinois Press, Urbana.

Sydow H, Sydow P. 1911. Notes and descriptions of Philippine fungi 1. Leafl. Philipp. Bot. 4:1151-1156.

Sydow H, Sydow P, Butler EJ. 1911. Fungi indiae orientalis. part 3. Ann. Mycol. 9:372-421.

Sydow H, Sydow P. 1912. Fungi from the Islands of Palawan. Leafl. Philipp. Bot. 5:1523-1547.

Sydow H, Sydow P. 1914. Fungi from Northern Palawan. Philipp. Journ. Sci. C. Bot. 9(2):157-189.

Sydow H. 1937. Neue oder bemerkenswerte australische *Micromyceten* 1. Ann. Mycol. 35:22-50.

Sydow H. 1938. Novae fungorum species-26. Ann. Mycol. 36:156-197.

Sydow H. 1939. Novae fungorum species-27. Ann. Mycol. 37:197-253.

MYCOTAXON

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Studies on the genus *Asteridiella* of China 2

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Abstract—*Asteridiella heliciae* parasitic on *Helicia cochinchinensis* and *A. sloaneae* parasitic on *Sloanea sinensis* are described and illustrated as new species.

Key words—*Meliolaceae, Proteaceae, Elaeocarpaceae*

The genus *Asteridiella* was proposed by McAlpine in 1897, its type being *A. solani* McAlpine (McAlpine 1897; Hansford 1961). The species of this genus are obligate parasites on higher plants and widely distributed in the tropical and subtropical regions of the World. Although attempts have been made to culture these fungi, both in the laboratory and on host plants (Hansford 1961; Goos 1978), no one has yet succeeded in doing so. The genus *Asteridiella* is similar to the *Amazonia, Appendiculella, Irenopsis*, and *Meliola*, but it differs from these genera of *Meliolaceae* in having cells protruding on the perithecial surface, and lacking appendages or setae (Mibey & Hawksworth 1997). *Asteridiella* is also the larger genus of the family *Meliolaceae*. Up to now, over 250 taxa of the genus have been described in world (Kirk et al. 2001), and over 54 taxa have been reported in China (Hu et al. 1996, 1999; Song et al. 1996, 2002). Two new species are described and illustrated here.

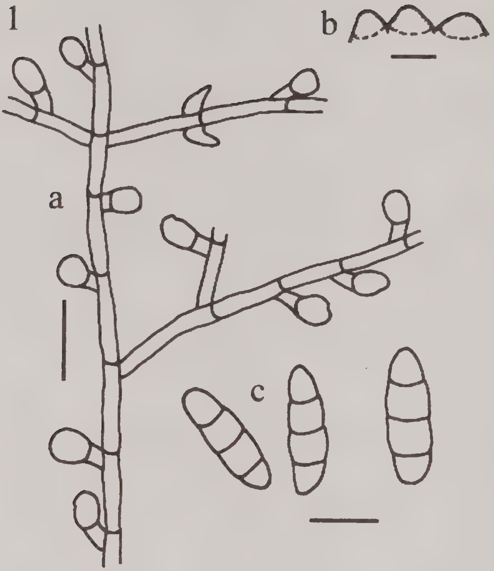
Asteridiella heliciae B. Song & T. H. Li, *sp. nov* Fig. 1

Similis Asteridiella knightiae sed differt appressoriis brevioribus (17-25 μm) et ascosporis minoribus (38-45×13-17 μm).

Etymology: *heliciae*, in reference to the host, *Helicia cochinchinensis.*

Colonies amphigenous, black, dense, velvety, scattered, up to 9 mm in diameter, rarely confluent. Hyphae brown, straight to nearly straight, with branches opposite and acutely branching, closely reticulate, cells mostly 17-30×5-6.4 μm. Appressoria alternate or unilateral, spreading, straight to slightly curved, 17-25 μm long; stalk cells cylindrical to cuneate, 5-10 μm long; head cells ovate or ellipsoidal, entire or sometime nearly lobate, 12-16 × 9-10 μm. Phialides mixed with appressoria, opposite to alternate, ampulliform, 13-18 × 6-8 μm. Mycelial setae absent. Perithecia scattered, black, globose, verrucose, up to 200 μm in diameter, surface cells conoid to mammillate, 13-20 μm high and 20-30 μm wide. Ascospores brown, cylindrical, obtuse or nearly acute at ends, 3-septatae, slightly curved, constricted at septum, 38-45 × 13-17 μm.

Corresponding author



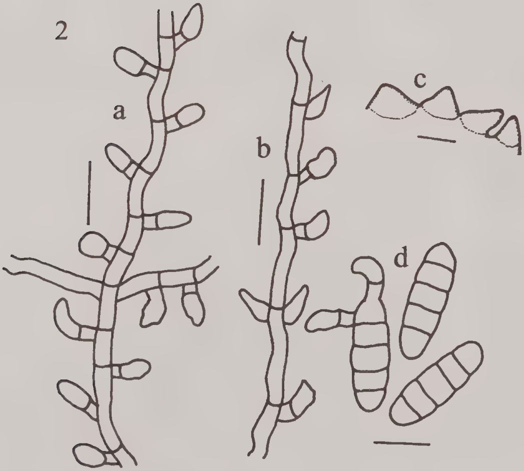


Fig.1 *Asteridiella heliciae* (a. hyphae with appressoria and phialides; b. surface cells; d. ascospores) (Bars = 25 μm)

Fig.2 *Asteridiella sloaneae* (a. hyphae with appressoria; b. hyphae with appressoria and phialides; c. surface cells; d. ascospores and one germinating ascospore) (Bars = 25 μm)

Holotype: *On leaves of Helicia cochinchinensis Lour.(Proteaceae). Ruyang County, Guangdong Province, China. November 30,1995, B. Song, HMIGD 34185.*

The new species is close to *Asteridiella knightiae* S. Hughes, but differs from this species in having longer appressoria (32-65 µm) and larger ascospores (72-79 × 25-28 µm) (Hughes 1978). It is also close to *Asteridiella caseariae* Hansf., but which differs in having irregularly branching hyphae, longer appressoria (23-30 µm), and head cells shallowly 2-3-lobate, nearly globose (14-19 × 15-18 µm) (Hanford 1961). In addition, two species of meliolaceous fungi, *Meliola heliciae* W.Yamam. and *Meliola heliciicola* Hansf., are recorded as occurring on *Helicia*, but both those species have mycelial setae and 4-septate ascospores (Yamamoto 1941; Hansford 1961).

This species is also a first record of *Asteridiella* on *Helicia*.

Asteridiella sloaneae B. Song, *sp. nov.* Fig. 2

Similis Asteridiella elaeocarpicola sed differt ascosporis minoribus (45-52 × 16-19 µm); et a A. amoena differt appressoriis non-oppositis et longioribus (15-22 µm), ascosporis grandioribus.

Etymology: *sloaneae,* in reference to the host, *Sloanea sinensis.*

Colonies epiphyllous, black, dense, arachnoid to velvety, scattered, up to 8 mm in diameter, sometime confluent. Hyphae brown, sinuous or nearly straight, mostly opposite branching acutely or lately, dense reticulate, cells mostly 15-22 × 6-7.5 µm. Appressoria bicellular, in alternate or unilateral arrangement, spreading, straight or bent, 15-22 µm long; stalk cells cuneate to cylindrical, 3-7 µm long; head cells cylindrical to ellipsoid or ovate, entire to angulose at apex, 12-17.5 × 7.5-11 µm. Phialides mixed with appressoria, opposite or alternate, ampulliform, 15-23 × 5.5-8 µm. Perithecia scattered to nearly aggregate, black, globose, up to 260 µm diam., surface cells conoid to mammillate, 15-19 µm high and 10-25 µm wide at base. Ascospores brown, oblong to nearly ellipsoid, obtuse, 4-septate, constricted at septum, 45-52 × 16-19 µm.

Holotype: *On leaves of Sloanea sinensis (Hance) Hemsl.(Elaeocarpaceae) Chebaling, Guangdong Provinica, China. November 2, 1993, Y. S. Ouyang and B. Song, HMIGD 34013.*

The new species is closely related to *Asteridiella elaeocarpicola* Hansf. parasitic on *Elaeocarpus monoceratis* from Philippines, which has larger ascospores (53-63 × 20-26 × 15-19 µm) (Hansford 1961). The new species is also similar to *Asteridiella amoena* (Syd.) Hansf. parasitic on *Sloanea faginea* from Costa Rica, which has opposite and shorter (9-13 µm) appressoria, and smaller ascospores (35-41 × 15-16 µm) (Hansford 1961).

This is the second record of *Asteridiella* on *Sloanea.*

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The authors wish to thank Prof. Dr. R. D. Goos of Department of Botany, University of Rhode Island (U.S.A.) and Prof. Dr. Richard P. Korf for serving as pre-submission reviewers and for their valuable comments and suggestions. They also acknowledge Prof. S Q Chen of South China Institute of Botany, Academia Sinica, Guangzhou, for identifying the host plants, and to Mr. Y.H. Shen of Guangdong Institute of Microbiology, Guangzhou, and Ms. A.L. Zhang for the technical assistance. This project was supported by the National Science Foundation of China (no. 30370012), the Natural Science Foundation of Guangdong (20000205; 020470), the Natural Science Fund for Distinguished Young Scholars from Guangdong Academy of Sciences, and the Foundation of Guangdong Institute of Microbiology.

References

Goos RD.1978. Field and laboratory studies of meliolaceous fungi in Hawaii. Mycologia 70:995-1006.

Hansford CG.1961. The *Meliolineae*. A Monograph. Sydowia Beih 2:1-806.

Hu YX, OuyangYS, Song B, Jiang GZ. 1996. *Meliolales* 1. Flora Fung. Sin. 4:1-270 (in Chinese).

Hu YX, Song B, Ouyang YS, Jiang GZ. 1999. *Meliolales* 2. Flora Fung. Sin. 11:1-252 (in Chinese).

Hughes SJ. 1978. New Zealand fungi 25. Miscellaneous species. N. Z. J. Bot. 16:311-370.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. Ainsworth & Bisby's Dictionary of the Fungi (9th ed.). CAB International, Wallingford, Oxon, UK.

McAlpine D. 1897. New South Wales Fungi. Proc. Linn. Soc. New South Wales 22:36-703.

Mibey RK, Hawksworth DL. 1997. *Meliolaceae* and *Asterinaceae* of the Shimba Hills, Kenya. Mycol. Pap.174:1-108.

Song B, Ouyang YS, Hu YX. 1996. Studies on the genus *Asteridiella* of China 1. Acta Mycol. Sin. 15:247-250.

Song B, Li TH, Shen YH. 2002. Ecological and floristic analyses of *Meliolales* (Fungi) in China. Journ. Trop. Subtrop. Bot. 10(2):118-127 (in Chinese)

Yamamoto W. 1941. Formosan *Meliolineae* 4. Trans. Nat. Hist. Soc. Formosa 31:47-60.

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A new species of *Perrotia* from New Zealand

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Abstract—A new species of *Perrotia* is reported from the Tongariro area in New Zealand. *Perrotia microspora* is described from branches of *Halocarpus bidwillii*. The ovoid ascospores and other hymenial elements indicate that *P. microspora* is closely related to *P. robusta* and *P. gallica* var. *gallica* known from Europe, and *P. gallica* var. *phyllocladi*, which is only known from a single locality in New Zealand.

Key-words—culture, Hyaloscyphaceae, key

Introduction

During a visit to the North Island of New Zealand in January and February 2003, an interesting discomycete was collected on a foray in the Tongariro National Park, on the foothills of Mt. Ruapehu. Microscopic examination showed that it is a species of *Perrotia*, which differed in morphology from all known species in the genus (Zhuang & Yu 2001), and is therefore described as new. The fungus was found growing on recently dead branches of *Halocarpus bidwillii*, a podocarp tree endemic to New Zealand. The culture that was isolated remained sterile.

Material and Methods

The material was studied in water and Lugol's iodine solution (IKI) and Melzer's reagent (Mlz). All measurements were taken in water, and drawings were made with a drawing tube. Colony colours were described according to Rayner (1970). The type specimen of *Perrotia microspora* has been deposited in the New Zealand Fungal Herbarium (PDD) of Landcare Research, Auckland.

Taxonomic Description

Perrotia microspora sp. nov. **FIGURES 1–4**

Apothecia erumpentia, solitaria vel gregaria, breve-stipitata; discus plano-concavus, pallide aurantiacus, 0.4–1.2 mm diametro (siccus); receptaculum cupulatum, pilis albis dense vestitum; stipes centralis, cylindricus, pilis albis vestitus. Pili cylindrici, 4–7-septati, obtusi, 70–100(–130) × 2.5–3.5 µm, parietibus hyalinis tenuis subtiliter granulosis. Excipulum ectale e cellulis prismaticis 8–15 × 5–7 µm parietibus hyalinis ad 1 µm crassis, agglutinatis compositum; excipulum medullare e hyphis intricatis 2–3 µm latis hyalinis compositum.

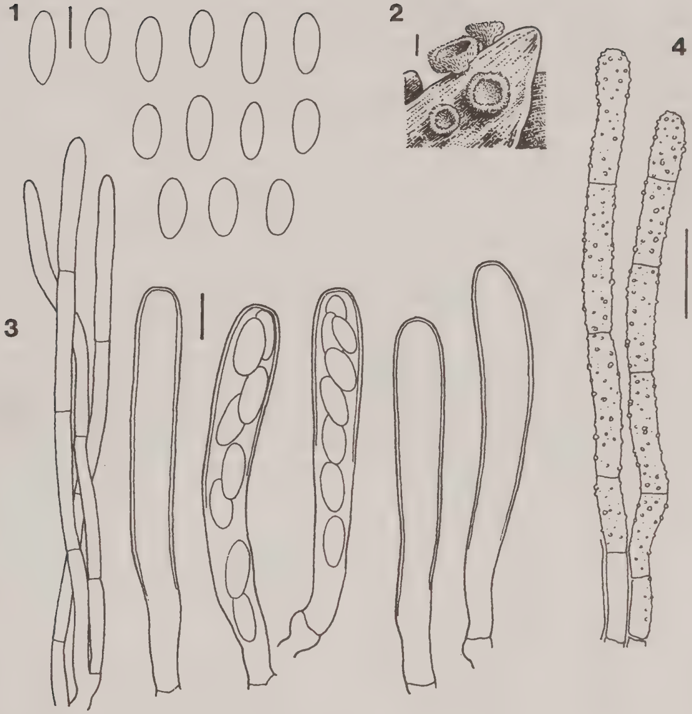
Asci octospori, cylindrico-clavati, apice late rotundato in iodo non caerulescente, pariete apicali nullo incrassato, 35–50 × 5.5–6.5 µm; ascosporae ovoideae vel late elliptae, hyalinae, non-septatae, guttulatae, 5.5–8.5 × 2.8–3.0 µm; paraphyses filiformes, septatae, obtusae, hyalinae, 2.0–2.5 µm latae, ascis 10–20 µm longiores.

Etymology – From Greek *micro-*, small, and Latin *spora*, spore, referring to the relatively small sizes of the ascospores as compared to other species of *Perrotia*.

Apothecia erumpent, solitary or gregarious, short-stalked; *disc* plano-concave, pale orange and partly hidden by an inrolled margin when dry, paler when moistened, 0.4–1.2 mm diam (dry); *receptacle* cupulate, densly clothed by pure white hairs; *stipe* central, cylindrical, up to 0.3 mm high and 0.2 mm wide, the surface covered with white hairs. *Hairs* cylindrical, 4–7-septate, obtuse, 70–100(–130) × 2.5–3.5 µm, the apical cell sometimes swollen and up to 4 µm wide, with relatively thin, hyaline walls bearing fine granules all over the surface.

Ectal excipulum composed of prismatic cells 8–15 × 5–7 µm, with hyaline, up to 1 µm thick, agglutinated walls, in the lower part of the receptacle oriented at a high angle to the surface, in the upper part lying almost parallel to the surface; *medullary excipulum* composed of tightly interwoven hyphae 2–3 µm diam., with slightly thickened, smooth, hyaline walls.

Asci 8-spored, cylindrical-clavate, apex broadly rounded, apical wall not thickened, not blueing in iodine (IKI-, Mlz-, also after KOH pretreatment), opening by an irregular tear at the apex, gradually narrowed towards the base, croziers present, 35–50 × 5.5–6.5 µm (non-turgescent (NT), water); *ascospores* ovoid to broadly-ellipsoid, ends broadly rounded to slightly pointed, hyaline, non-septate, smooth, thin-walled, containing guttules, 5.5–8.5 × 2.8–3.0 µm; *paraphyses* filiform, septate, obtuse, some slightly narrowing toward the blunt tip, hyaline, smooth-walled, 2.0–2.5 µm wide, exceeding the asci by 10–20 µm (NT).



Figs 1–4. *Perrotia microspora*, PDD 78361, holotype (in water). 1. Ascospores. Bar = 5 µm. 2. Habit of apothecia. Bar = 0.5 mm. 3. Paraphyses and asci. Bar = 5 µm. 4. Apothecial hairs. Bar = 10 µm.

Holotype – NEW ZEALAND, North Isl., Taupo distr., Tongariro Nat. Park, near Whakapappa, Taranaki Falls track, alt. 1400 m, on recently dead, still attached branches of *Halocarpus bidwillii* (Podocarpaceae), G. Verkley 1883, 26.I.2003 (PDD 78361, holotype), also living ex-type cultures PDD and CBS 114327 (mass-sexual).

Description of cultures (15° C, n-UV, 12h-rithm) – Colony on OA reaching a diam of 24–29 mm in 18 d, with an even, glabrous and colourless margin; immersed mycelium Ochreous to Pale Luteous, and in sectors also Saffron, in the centre covered by pure white, floccose aerial hyphae; reverse concolourous. On PDA 25–28 mm diam in 18 d, margin as on OA; immersed mycelium largely colourless, without aerial mycelium; reverse with some Salmon or faintly Buff in the centre. On 3 % MEA 25–27 mm in 18 d, margin as on OA; immersed mycelium mostly hidden under pure white, felty to floccose aerial mycelium; reverse in the centre Orange, surrounded by Luteous tinges. No sporulation was observed *in vitro*.

Discussion

Perrotia microspora is placed in the genus *Perrotia* on the grounds of the structure of the asci, which are thin-walled, and have broadly rounded, inamyloid apices. Twenty species have thus far been described in *Perrotia* (Dennis 1963, Raitviir 1970, Spooner 1987, Wang & Haines 1999, Zhuang & Hyde 2001, Zhuang & Yu 2001), four of which have been found in New Zealand, viz., *P. lutea* (Phillips) Dennis, *P. alba* Dennis, *P. apiculata* (Dennis) Spooner, and *P. gallica* var. *phyllocladi* (Dennis) Spooner. *P. microspora* resembles the last mentioned species and *P. robusta* Grelet ex Spooner in habit and colour of the apothecia, and in the shape of the ascospores. There are, however, also important differences between these species. The spores of *P. gallica* var. *phyllocladi* are larger (8.5–11.5 × 5.0–6.0 µm) than those of *P. microspora*, and the hairs are longer (200–250 µm; Spooner, 1987). The ascospores of *P. robusta* are also considerably larger (11–15 × 7–9 µm) than those of *P. microspora*. *P. gallica* var. *phyllocladi* was originally described as *Trichoscyphella phyllocladi* by Dennis (1961), but Spooner (1987) found it morphologically indistinguishable from the European *P. gallica*. He accepted it at varietal rank because of the geographical isolation and difference in host.

At the site where *P. microspora* was collected, the host *Halocarpus bidwilli* grows jointly in a subalpine podocarp vegetation with *Phyllocladus aspleniifolius* var. *alpinus* (= *Ph. alpinus*), which is the only known host of *P. gallica* var. *phyllocladi*. The genus *Halocarpus* is endemic to New Zealand, where three species are known.

Key to the species of *Perrotia* in New Zealand

1. Ascospores multiseptate, 100–160 µm long .... *P. lutea*
1. Ascospores 0–1-septate, not over 20 µm long 2

2. Ascospores rhomboidal, on bark of *Nothofagus* .... *P. apiculata*
2. Ascospores ovoid, ellipsoid or cylindrical 3

3. Ascospores cylindrical to ellipsoid, 1-septate, 12–17 × 3.5–4.5 µm, on twigs of *Aristotelia fruticosa* .... *P. alba*
3. Ascospores ovoid or broadly ellipsoid, continuous, on other substrates 4

4. Ascospores 8.5-11.5 × 5.0-6.0 µm, apothecial hairs 200-250 µm long, on *Phyllocladus* .... *P. gallica* var. *phyllocladi*
4. Ascospores 5.5–8.5 × 2.8–3.0 µm, apothecial hairs 70–100(–130) µm long, on *Halocarpus bidwillii* .... *P. microspora*

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Literature Cited

Dennis RWG. 1963. A redisposition of some fungi ascribed to the Hyaloscyphaceae. Kew Bull. 17: 319–379.

Raitviir A. 1970. Synopsis of the Hyaloscyphaceae. Scripta Mycol. 1: 1–115.

Spooner BM. 1987. Helotiales of Australasia: Geoglossaceae, Orbiliaceae, Sclerotiniaceae, Hyaloscyphaceae. Biblioth. Mycol. 116: 1–711.

Rayner RW 1970. A mycological colour chart. Commonwealth Mycological Institute, Kew.

Wang Y-Z, Haines JH. 1999. A new species of *Perrotia* from Taiwan. Mycotaxon 72: 461–464.

Zhuang WY, Hyde KD. 2001. New species of *Lachnum* and *Perrotia* from Hong Kong, China. Mycologia 93: 606–611.

Zhuang WY, Yu ZH. 2001. Two new species of *Perrotia* (Helotiales, Hyaloscyphaceae) from tropical China and a key to the known species of the genus. Nova Hedwigia 73: 261–267.

MYCOTAXON

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Book reviews and notices

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General

Centenary Review of the Fungal Diversity Investigations in Bulgaria. Edited by Cvetomir M. Denchev & Ganka G. Bakalova. 2002. Bulgarian Mycological Society, c/o Institute of Botany, 23 Acad. G. Bonchev Street, BG-1113 Sofia, Bulgaria. Pp. 71. ISBN 954 995911 2. [In Bulgarian with English summary.] Price: Not indicated.

This booklet commemorates 100 years of mycological research in Bulgaria. It describes the history of investigations of various non-lichenized groups and the problems and trends of mycological studies in the country. There are extensive lists of literature references to some sections, and a red-list of 215 macromycetes for the country first issued in 2000 is reproduced. The issue of endangered micromycetes is also raised, especially with reference to smut fungi, although it is noted that plant pathogens might be viewed as an "anti-resource" the desirability for the conservation of which needed to be assessed case by case. Provided this work is widely circulated in the country, it should do much to raise the level or awareness of conservationists and ecologists of the need to pay more attention to the fungi. It also provides a starting point for someone wishing to study the Bulgarian mycobiota for the first time. The editors are to be congratulated on this initiative.

Origen de Los Nombres Científicos de Los Hongos. By Miguel Oltra. April 2003. Second edition. Real Jardín Botánico, Claudio Moyano 1, E-28014 Madrid, Spain. [Monografías de la Sociedad Micológica de Madrid No. 1.] Pp. 160. ISSN 0214 140 X. Price: € 9.

A second edition of this extensive glossary, first released in 1996, which provides the meanings in Spanish of generic and specific names used for macromycetes and a few other fungi, together with details of the Latin, Greek, other words, or individuals on which they are based. Much seems to be unchanged from the original printing, however, and the most recent title in the bibliography dates from 1991. Nevertheless, as the meanings of words do not "date", it remains of value not only to Spanish speakers but also to other mycologists endeavouring to track down the origins of particular fungal names.

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

Recommended English Names for Fungi in the UK. By Elizabeth Holden. [2003.] Plantlife International, 14 Rollestone Street, Salisbury, Wiltshire SP1 1DX, UK. [Available from Plantlife Bookstore, Summerfield Books, Main Street, Brough, Cumbria CA17 4AX, UK.] Pp. 24. ISBN 1 872613 99 3. Price £ 6.

This book represents the output of an initiative of the UK's Fungus Conservation Forum, supported by the British Mycological Society, Countryside Council for Wales, Environment Heritage Service (Northern Ireland), English Nature, Plantlife International, and Scottish Natural Heritage. The aim was to provide recommended English names for around 1000 species to provide them with "a more popular, accessible identity" (p. 5). Names were gleaned from 30 modern field guides and other sources (listed on p. 6), and English names coined for the first time for around 400 species. Where competitive names occurred, a project steering group made a choice. However, the steering group could not agree on five species for which "two equally well-established names" existed, and for those both names are retained (!; e.g. Magic Mushroom or Liberty Cap for *Psilocybe semilanceata*). Scientific names are generally avoided, although "Amanita" was permitted as it is accepted in a leading English dictionary. The list is wide-ranging, including not only macromycetes but also some rusts and smuts and a few other pathogens of native plants, but no mildews. Names of crop and garden pathogens are generally omitted, as are those for lichenized fungi, which makes the overall title somewhat misleading. However, despite the inputs of numerous mycologists, some errors and strange names remain. For example, I was shocked to see *Ophiostoma ulmi* down for Dutch Elm Disease (*O. novo-ulmi* was the cause of the last UK epidemic), and fail to understand why *Schizophyllum commune* should be referred to as the Common Porecrust when it has neither pores nor forms a crust. I really wonder if creating names in colloquial languages where there were none improves accessibility, and question the wisdom of encouraging the use of common names. The idea may appeal to conservation agencies familiar with dealing with birds, mammals and plants, but for fungi it can only serve to complicate exchanges with specialists nationally and both amateur and professional mycologists internationally. Hopefully, the print run was small.

Atlas of the Geographical Distribution of Fungi in Poland. Fascicle 2. Edited by Władysław Wojewoda. December 2002. Władysław Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31 512 Kraków, Poland. Pp. 129. ISBN 83 85444 98 X. Price € 17.

The first fascicle of this series was issued in 2000 and covered in *Mycotaxon* **82**: 477 (2002); it treated ten species. This second fascicle covers 26 basidiomycetes belonging to 23 genera: *Amyocorticium, Antrodia, Bovista, Clavariadeplphus, Clavulicum, Conohypha, Daedaleopsis, Diplotomitoporus, Eichleriella, Fomitoporia, Fomitopsis, Hymenochaete, Irpicodon, Punctularia, Pycnoporellus, Rhodotus, Scotomyces, Sistotrema, Suillus, Syzygospora, Thanatephorus, Trichaptum,* and *Tubulicrinis.* As in the previous fascicle, detailed discussions of the ecology and distribution are followed by distribution maps with records divided by date categories, and lists of specimens studied. A note from the Editor includes corrigenda to author citations and places of publication of names given in fascicle 1, which were pointed out as needing attention in the *Mycotaxon* review of that part. I was pleased to see that more attention has been accorded to nomenclatural details in this second fascicle, which augurs well for subsequent installments. The increase in the number of species covered in this second part is commendable, and hopefully that will the continued or increased further in future fascicles

Basidiomycetes

Xerocomus s. l. By Heidi Ladurner & Giampaolo Simonini. June 2003. Edizioni Candusso, Via Ottone Primo 90, I-17021 Alassio SV, Italy. [Fungi Europaei Vo. 8.] Pp. 528, col. photographs 290, col. plates 21, figs 343. ISBN 88 901057 2 0. Price € 56.

At last we can purchase a well-produced major work published simultaneously in Italian and English. It contains many descriptive photographs, good illustrative plates and many line drawings; so many in fact that at times they give little help in identification. The keys are excellent and very much to the point. The complete work is printed on good quality paper, which gives perfect reproduction to the photographs, and is well bound.

The Introduction states the following. 'After many years of frustration, the decision was taken to make every effort to describe and illustrate in detail as many European *Xerocomus* species as possible'. This it has done, but the conclusion is far from the full international opinion, and I find increases the frustration; it is this factor that makes the book compulsive reading. Again it must be emphasised that much of the work is original, crying out to be read and pondered over, it is for this reason that individual species have not been selected for comment in this review

To anyone at all interested in *Boletus* this book is a must, it will confuse at times but on the other hand one should take a long look at it and consider the points it is putting forward before reaching one's own conclusion. The one regret British mycologists should have is that the only British material examined by the authors was *Boletus (Xerocomus) rubellus* and *Pseudoboletus (Xerocomus) parasiticus.*

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***Mycena* D'Europe.** By Giovanni Robich. May 2003. Associazione Micologica Bresadola, Via A. Volta 46, I-38100, Trento, Italy. Pp. 728, col. plates. ISBN not indicated. Price: € 85.

This beautifully presented book is not a critical work on the genus; neither does it cover all European *Mycena* species, so the title is rather misleading. One hundred and forty three taxa are described, comprising 117 species of *Mycena* plus 26 varieties or forms. Eight species and three forms are described for the first time. The author accepts the sections of Maas Geesteranus (1992) in a broad sense and organises the descriptions of species studied by the author within these sections. There is no appraisal of the taxonomic uncertainties in *Mycena* s.l. nor reference to recent developments, such as the separation of the *Calodontes* group into *Prunulus* (Redhead et al. 2001). A phytogeographical commentary is not included, neither is the distribution of species in Europe discussed. Most of the collections studied are from Italy and a number of European species, some common, are surprisingly missing. However, whatever the criticisms, this is a formidable piece of work; the author has sought to locate most European species and in some cases even found species described from America. There are unique illustrations including many not seen before in any book. The author is to be congratulated in having the courage to produce such a work on *Mycena*, a difficult genus with new species being frequently described. At least here we have the first European illustrated book solely on *Mycena*, an historical achievement.

The introduction is a short paragraph with no details of materials and methods. After a description of the genus is a key to the sections; all keys are duplicated in English, otherwise the text is in Italian, or Latin in the case of new taxa.

Each taxon is dealt with under the headings: basionym, synonyms, original diagnosis, introduction, reference illustrations, macroscopical description, microscopical description, exsiccata, and bibliography. Each has one or more colour plates and a page of microscopical drawings. These are sensibly arranged in a standard pattern but unfortunately have no legend. The drawings are a striking feature of the book, being an excellent synthesis from microscopical observation, although the author does not indicate if these are schematic or made with a drawing tube. It is not stated if the drawings are derived from one or more collections or whether they represent intraspecific variation. It would be more helpful to keep drawings from separate collections identifiable; however, I consider the drawings mostly faithful to his understanding of the taxa known to me. At the beginning of the large sections, like *Filipedes* and *Fragilipedes*, there is a page of drawings with a limited legend and it is unclear what purpose they serve. Most entries are greatly lengthened by the inclusion of an extensive list of illustrations; clearly, the author keeps a database of such illustrations. For example, *Mycena pura* (i.e. *Prunulus purus*) has 89 illustrations cited. It would have been reasonable to cite good representative examples up to a maximum of five, thus reducing the size of the book and permitting inclusion of detailed legends to the drawings and photographs. The latter are mostly very good but lack ecological information and details of the collection shown. The authors of the photographs are listed at the beginning of the work, rather than with the illustration. Several appear to be unrepresentative of the species. For example, those of *M. urania* and *M. mirata* appear to be of *M. filopes*. The former is a violet coloured species and the latter has fewer lamellae than illustrated.

The author frequently provides tables for comparison of similar species, which is very helpful; however, it is not clear if the details given encompass intraspecific variation. In some cases, the tables usefully include species that are not otherwise described in the book. The author does not seem to appreciate the value of aspect ratio values for spores (q values); these are very useful in *Mycena*, but they are not cited and the statistical validity of the spore measurements given is unclear.

In sect. *Adonideae*, *M. floridula* is accepted as a separate taxon to *M. adonis,* yet the question of the status of *M. floridula* sensu Kühner is not addressed. The sour tasting form of *M. flavoalba* is accepted as a separate variety; it seems odd that this has been noticed, since taste in not usually a feature of *Mycena*, and perhaps a closer look at these varieties will yield other differences. In sect. *Basipedes* the author sensibly includes in his key species Maas Geesteranus allocated to their own section. There are valuable accounts of *M. rhenana* and *M. tenuispinosa* with useful photographs; these are a real coup for the author. It is strange, however, that *M. mucor* and *M. bulbosa* are only covered in the key, since both are common and widespread in Europe. Users should beware of an error in the key here; *M. bulbosa* has a plicate basal disk when young, rather like *M. stylobates*.

Section *Calodontes,* recognised by Redhead et al. (2001) as separate from *Mycena* and referred to *Prunulus*, is covered with six varieties or forms of *P. purus* and two of *M. rosea* but there is no entry for *M. kuehneriana* or *M. pearsoniana*. Since the forms of *P. purus* do not differ microscopically, these could have been covered by two pages of photographs and one set of drawings. Only two species are described in sect. *Cinerellae*, *M. clavicularis* and *M. pseudopicta*, both with excellent photographs. *M. cinerella*, a common species does not appear even in the key, neither does *M. concolor*.

Among the extra species recently described in sect. *Filipedes* is *M. erianthi-ravennae* (Robich & Marchetti 1999). The photograph and description shown here are identical with my understanding of *M. chlorantha*, which is a species the author does not include in the book, so is apparently unknown to him. In the table comparing the newly described species, the author states that *M. chlorantha* has 16-22 lamellae reaching the stipe and no caulocystidia. In fact collections in my possession have from 14 to over 30 full lamellae and caulocystidia like those depicted in the drawings given for the new species. The substrates for both are marine grasses.

The values used for *M. chlorantha* by the authors are taken from Maas Geesteranus (1992), rather than by direct observation. Another of the recently described species in this section, *M. ticensis* (Robich 1966), looking remarkably like *M. flavescens*, is compared with *M. xantholeuca*, which is quite dissimilar microscopically; it would have been more appropriate to compare it with *M. flavescens* and *M. arcangeliana*.

In the burgeoning section *Fragilipedes* the author describes three new taxa, and adds some species, described from America, previously unrecorded from Europe. *Mycena calceata* (Robich 1996) is strangely placed in sect. *Insignes*. The author refers to the radiating fibrils attaching the stipe to the substrate as justification. This form of attachment is common in *Mycena*, and especially notable with *M. arcangeliana*. *Insignes* species are characterised by a viscid pileus and stipe, in some cases with a separable pellicle. *M. calceata* has neither of these characters. Curiously, the stipe is also described as insititious, and with a basal disk. In the sect. *Polyadelpha*, a new species, *M. catalaunica* is described growing on the leaves of *Quercus ilex* but it is not compared with *M. quercus-ilicis*, but three other species. *M. quercus-ilicis* is a widespread and common species in southern Europe so it is surprisingly missing from the book. The citrine colour of the stipes in the photograph of the described species, suggest that it might be Kühner's invalidly published *M. quercus-ilicis* var. *citrina* (see Maas Geesteranus 1989).

Bearing in mind the criticisms and cautionary remarks contained in this review, there is much of value to be obtained from this work.

Maas Geesteranus RA. 1989. Conspectus of the Mycenas of the Northern Hemisphere 11 - *Proceedings of the Koninklijke Nederlanse Akademie van Wetenschapen, C,* **92**: 89-108.

Redhead SA, Vilgalys R, Moncalvo J-M, Johnson J, Hopple JS. 2001. *Coprinus* Pers. and the redisposition of *Coprinus* species *sensu lato*. *Taxon* **50**: 203-241.

Robich G. 1996. On a new species of *Mycena* from Spain. *Persoonia* **16**: 245-248

Robich G, Marchetti M. 1999. *Mycena erianthi-ravennae,* una nuova specie della sezione *Filipedes* dall'Italia. *Rivista di Micologica* **42**: 291-298

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Die *Cortinariaceae* Österreichs. By Gerwin Keller & Meinhard M. Moser. 2001. [Catalogus Florae Austriae Vol. 3(2); Biosystematics and Ecology Series 19.] Pp. 20, 48 col. plates. Austrian Academy of Sciences, Vienna. Price € 45.

The aim of the *Catalogus Florae Austriae* series is to describe and document the biodiversity and the biological resources of the country. The difficult task of addressing the biodiversity of *Cortinariaceae* was carried out by Meinhard Moser, one of the world's experts in agarics, especially *Cortinarius*, in collaboration with his former student Gerwin Keller. The genera *Cortinarius* (353 spp.), *Dermocybe* (353 spp.), *Galerina* (51 spp.), *Gymnopilus* 11 spp.), *Hebeloma* (46 spp.), *Inocybe* (140 spp.), *Leucocortinarius* (1 spp.), *Naucoria* (13 spp), *Phaeocollybia* 6 spp.), *Phaeogalera* (4 spp.), and *Rozites* (1 spp.) are considered. The data for these books were compiled from the literature; moreover, herbarium specimen have been examined and included while uncertain records and determinations have been omitted. Importantly, the floristic information is supplemented by ecological data and remarks on similar species. An appendix with 48 original colour pictures is included. A register of genera and species epithets helps one to easily find data of interest. This book is very useful to Austrian mycologists in comparing and checking their collections. Furthermore, due to the well-documented ecological data, it is valuable for everybody interested in *Cortinariaceae* and their ecology in boreal habitats in general.

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Tanzanian Mushrooms: Edible, harmful and other fungi. By Marja Härkönen, Tuomo Niemelä & Leonard Mwasumbi. October 2003. Botanical Museum, Finnish Msueum of Natural History, University of Helsinki, P. O. Box 7, FIN-00014 Helsinki, Finland. [Norrlinia Vol. 10.] Pp. 200, figs 205. ISBN 952 10 1420 2. Price: € 25.

What a superbly researched and presented book, "born of a love for fungi and a love for Tanzanians" (p. 5). In essence it is a second edition of *Edible Mushrooms of Tanzania* (1995), which has long been out of print, combining information on the traditional uses of fungi with modern knowledge – and illustrated almost entirely in colour. It starts with an overview of habitats, the kinds of fungi, and what they do, highlighting mycorrhizas, lichens, *Termitomyces* mutualisms, and wood decay, through methods of study, to Mushrooms and Tanzanian people. This last section is based on interviews with members of 35 tribes, using a standardized series of questions, an approach to ethnomycological studies pioneered by Marja Härkönen. Following further sections on edible mushrooms (with traditional and adopted recipes) and poisonings, detailed treatments of about 100 species follow, all beautifully illustrated by colour photographs. For each, the scientific name and local vernacular names are provided, followed by comments on edibility, a description, habitat information, notes on possible confusions, and details of the spores. Reflecting the paucity of our knowledge of African macromycetes, a number of the species are only identified "aff.", three are newly described (*Clavulina wisoli, Phellinus amanii, Russula harkoneniana*), and one new combination is made (*Funalia polyzona,* syn. *Polyporus polyzonus*).

This book, provided it can be made widely available in Tanzania, is sure to stimulate the study of the larger fungi in the country, and will also serve as a great field guide for mycologists and other naturalists enjoying safari holidays there. The modest cost results from funding by the Department for Development Policy in the Ministry for Foreign Affairs in Finland; they are to be congratulated on appreciating the long-term development value of such a book.

Classis *Ustomycetes* (Ordines *Tilletiales, Ustilaginales* et *Graphiolales*). By Cvetomir M. Denchev. 2001. Academica "Prof. Marin Drinov", BG-1113 Sofia, Bulgaria. [Fungi Bulgarica Vol. 4.] Pp. 286, figs 67. ISBN 054 430 755 9. Price: Not indicated.

This treatment of the smut fungi and their allies of Bulgaria covers 114 described and 30 as yet unnamed species, occurring on 162 host plants. Keys and descriptions are provided, along with habit sketches of infection and scanning electron micrographs of the spores of many of the species. The text is first given in Bulgarian and then followed by a 49 page version in English. The latter includes descriptions and keys, together with information on hosts and localities in the country. A host index is also provided. The work is generally well produced, although there are some minor nomenclatural glitches, and the quality of the paper scarcely does justice to the scanning electron micrographs. This is clearly a major contribution to our knowledge of the smut fungi of the region, and the author is to be congratulated upon it. However, the continued extensive use only of different hosts as distinguishing characters in the keys to some genera grated . . . . and makes me worry over both species concepts and the impression the approach gives to non-mycological systematists who might chance to see it.

Setas de Madrid. By Francisco de Diego Calogne. October 2003. Consejería de Medio Ambiente, Comunidad de Madrid, Madrid, Spain. Pp. 262, col. plates. ISBN 84 451 1530 8. Price € 12.

The Sociedad de Micológica de Madrid already has a fine series of four full-colour booklets on the fungi of the Comunidad de Madrid, the most recent of which was reviewed in *Mycotaxon* **80**: 515 (2001). The Comunidad covers some 8000 km – and embraces some of the most important areas of upland biodiversity in Spain, including the Le Pedriza UNESCO Biosphere Reserve. Following a brief introduction to macrofungi and their environmental importance, and lists of points to bear in mind when collecting in relation to both fungal conservation and safe-eating, the bulk of the work comprises over 200 first-rate colour photographs with facing text explaining the key features of the species, their ecology, and comestability (or otherwise). The emphasis is naturally on edible species, but especially impressive is a section that not only lists the species associated with particular trees, but has line-drawings of the diagnostic features of the trees themselves to facilitate their identification — an excellent case of lateral thinking! I used this during the British Mycological Society's overseas foray to Mataelpinio, Madrid, in November 2003 and was most impressed by the utility of this last section to one still learning the trees of the region, let alone the fungi! It could only have been produced by 'Paco' Calogne, the President of the Sociedad de Micológica de Madrid, who has such an in-depth understanding of the macrofungi of the region, and that its importance and need has been recognized by the Comunidad (reflected in the price) is heart-warming. The print-run was 3000, and the immediate stocks evidently ran out on the first day of the Sociedad's annual exhibition in Madrid. The local demand will be huge; if you are interested in the macrofungi of upland mediterranean areas it would be wise to order a copy quickly.

Fungi, Basidiomycota, Aphyllophorales: Coniophoraceae, Corticiaceae, Gomphaceae, Hymenochaetaceae, Lachnocladiaceae, Stereaceae, Thelephoraceae. Tulasnellales: Tulasnellaceae. By Alina G. Greslebin. March 2003 ['2002']. Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina, Buenos Aires, Argentina. [Distributor: Koeltz Scientific Books, Herrnwaldstrasse 6, D-61462 Königstein, Germany.] [Flora Criptogámica de Tierra del Fuego Vol. 11(4).] Pp. 212, figs 31. ISBN 950 9859 84 2. Price: US $ 30.

This installment covers the families *Coniophoraceae* (2 genera), *Corticiaceae* (36), *Hymenochaetaceae* (1), *Lachnocladiaceae* (3), *Stereaceae* (1), *Thelephoraceae* (2), and *Tulasnellaceae* (1). It is based on both previously published reports and particularly 1700 collections made by the author in seven visits in spring and autumn during the years 1995-99.

Keys to genera and species are provided, with lists of synonyms, detailed descriptions, information on habitat and collections studied, and particularly carefully prepared line drawings of microscopic features. Many of the drawings are reproduced from earlier works by other mycologists, although this is not indicated in the legends themselves; this is mentioned in the Introducción, but without the full bibliographic citations. Sadly, no photographs were provided, which is unfortunate as many of these fungi have distinctive basidiomata.

Nomenclaturally, the usage of ": Fr." in the citations of accepted species is somewhat erratic, and authors names of species should not have been cited where other than the type infraspecific taxon was being referred to. Interestingly, the normally algicolous or lichenicolous *Athelia arachnoidea* is cited as growing on fallen wood of *Nothofagus antarctica*; I wonder if the algae or lichens were overlooked. It is also a pity that the obsolete ordinal name *Aphyllophorales* was retained, and that no account of the relationships of the treated families as revealed by molecular phylogenetic studies was included.

Nevertheless, there is no doubt that this study has been carefully executed, and that it will be of value to all endeavouring to identify corticioid and similar resupinate fungi not only in Tierra del Fuego but also in other parts of southern South America.

Ascomycetes

Clavicipitalean Fungi: Evolutionary biology, chemistry, biocontrol, and cultural impacts. Edited by James F. White Jr, Charles W. Bacon, Nigel L. Hywel-Jones & Joseph W. Spatafora. 2003. Marcel Dekker, 270 Madison Avenue, New York, NY 10016, USA. [Mycology Series Vol. 19.]. Pp. xi + 575. ISBN 0 8247 4255 9. Price: US $ 195.

This is a wide-ranging monograph, as will be evident from the title, and is covered here as it includes seven chapters with a taxonomic focus. Gams & Zare provide keys to the clavicipitaceous anamorphs parasitizing nematodes and other invertebrates, with some illustrations; this will now be the first place to go to identify these fungi! Hodge then covers a wider range of anamorphs, and Bischoff & White the teleomorphs on plants, just to the generic level and with keys to genera but not the species; it is pity that step could not have been taken to complement Gams & Zare's contribution, but I guess space could then have presented a problem.

Lewis, Sullivan & White survey the features of the *Balansieae,* and enumerate 25 accepted species, giving details of hosts but not distribution nor a key. In the case of *Epichloë,* Leuchtman tabulates details of ten species with experimentally tested host ranges, including diagnostic details of the ascospores. A tabular approach is also used by Alderman for *Claviceps,* which covers 39 species; 42 are discussed in detail in the text, this is the fullest compilation of species of the genus to have appeared for many years and is to be particularly welcomed. Finally, Ryley introduces the new generic name *Nigrocornus* for the single species *N. scleroticus* (syn. *Epichloë sclerotica*), and provides detailed information in its *Ephelis* anamorph and host range.

Other chapters in the book concern issues of speciation, evolution, secondary metabolites, molecular genetics of alkaloid biosynthesis, genetic manipulations, the molecular basis of host-pathogen interactions, toxicity, commercial applications, use in biocontrol, and possible defensive roles in grasses.

While the systematic sections particularly lack the cohesive approach to be expected in a single- or few authored book, there is no doubt that this much needed reference work on these fungi will be valued by all struggling to identify them as well as utilize or understand their biologies.

Lichen-forming Fungi

Catalogue of the Lichen Family *Porinaceae.* By Patrick M. McCarthy. August 2003. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin. [Bibliotheca Lichenologica No. 87.] Pp. 164, figs 13, tables 1. ISBN 3 443 58066 1. Price: € 46.

This family of pyrenocarpous lichens in the *Trichotheliales* as interpreted here includes three genera and 394 species: *Polycornum* (1 species), *Porina* (359), and *Trichothelium* (34). Over 700 synonyms are listed, as are various doubtful and excluded species, many referable to other quite unrelated families. For each accepted species, places of publication and synonyms are provided, followed by lists of countries from which the species have been reported, together with references to the pertinent published reports. In the case of commoner species, distribution maps are also presented.

Although this is a catalogue of the taxa and their records (and so without descriptions and keys), it is a masterly and critically researched world overview of one of the commonest groups of pyrenocarpous lichens in the tropics. Europe contributes at least 80 % of the literature reports, and at least 50 % of the synonymy, but supports less than 15 % of the species. The author estimates that the true world-wide diversity of the family "will probably exceed 500 taxa" (p. 10); I suspect that will prove to be on the low side from my own brief encounters with the genus in the tropics, especially southern India.

Three new scientific names are introduced: *Porina biroi* comb. nov. (syn. *Clathroporina biroi*), *P. coarctata* nom. nov. (syn. *P. aggregata* nom. illegit.), and *P. peregrina* sp. nov.

It is evident that there is much research behind this work that is not presented here, particularly with reference to the types Dr McCarthy has personally checked and on which rest some of the taxonomic decisions presented. Hopefully he will have time to do that and prepare a subsequent publication in due course, so that this catalogue can evolve into a world monograph. For the moment, however, we have a valuable reference source that should serve to stimulate further work on and facilitate identifications in the family.

Catalogue of Lichens in Japan, 1879-2000. By Yoshiatsu Ikoma. 2002. Y. Ikoma, Teramachi 45, Tottori City, Japan. Pp. v + 667. ISBN not indicated. [In Japanese.] Price: ¥ 13 000.

Checklist of Japanese Lichens. Edited by Syo Kurokawa. July 2003. National Science Museum, Tokyo, Japan. Pp. iv + 128. ISBN and Price: Not indicated.

Two checklists of lichens known from Japan published within a year or so of each other, but the first is not listed or mentioned in the Introduction to the second. Yet the two are to a considerable extent complementary. The first must have been known to the editor and team working on the second, as it was reviewed and also advertised in the Japanese journal *Lichenology* **1**(2): 86-87 (2002).

Ikoma's catalogue provides full citations for the places of publications of names, details of publications with records from Japan, citations of exsiccates, sometimes details of type collections (whether from Japan or not), and reports of species named only to genus, and cross-references of synonyms to accepted names. It is therefore very much a valuable sourcebook for researchers rather than a checklist for easy reference, but it is not clear whether all the bibliographic references have been checked. While the Japanese citations may well all have been verified, some of the older ones could have been copied from Zahlbruckner's *Catalogus* as in at least some cases they reproduce his mistakes. In some cases there are refreshingly frank notes, such as "must re-examine" (p. 171).

If the *Catalogue* suffers from reference overload, the *Checklist* is the other extreme. It accepts 1557 species reported "before July of 2003" (p. iv) and cross-references synonyms to accepted names, but gives no literature references whatsoever by the generic or species entries. There is, however, an extensive list of "Selected literature" at the end of the work, which also omits earlier works by Ikoma (e.g. Ikoma 1983).

The Kurokawa *Checklist* is surely the more authoritative, and involved an Editorial Board of eleven lichenologists from four countries, but will need to be used in conjunction with Ikoma's *Catalogue*.

Ikoma, Y. (1983) *Macrolichens of Japan and Adjacent Regions.* Tottori City: Y. Ikoma.

Bibliography of Japanese Lichenology. By Yoshiatsu Ikoma. 2001. Y. Ikoma, Teramachi 45, Tottori City, Japan. Pp. iv + 173. ISBN not indicated. [In Japanese.] Price: ¥ 2000.

This work is an alphabetical listing of publications on the lichens of Japan, including Japanese and other titles. It endeavours to be as complete as possible, including reviews and notices of publications in Japanese journals as well as the works themselves. In the absence of any topic index, the volume is not one that can be a first port of call in any identification work, but where it is necessary to check the complete works of a particular Japanese worker it will be invaluable.

A History of Japanese Lichenology. By Yoshiatsu Ikoma. 2002 ['2001']. Y. Ikoma, Teramachi 45, Tottori City, Japan. Pp. x + 401. ISBN not indicated. [In Japanese.] Price: ¥ 12 000.

This work is not so much a literary history, but an annotated bibliography of works on the lichens of Japan, including facsimile reproductions of key papers in whole or in part. It spans the Linnaean period and Thunberg's contributions through to those by Asahina, Degelius, Gyelnik, Hale, and Ahti, but does not mention studies by most of the author's Japanese contemporaries.

Dr Ikoma has been publishing on lichens since 1951, and his doctoral dissertation of 1957 was on the macrolichens of Japan. He is thus well placed to consider the history of the subject after his active immersion in it for over half a century.

The present work is very much a personal eclectic of what he found of interest, with copies of portraits, title pages, plans of the Vega ship used in early explorations, lists of publications by selected workers, etc, etc. There is also a very detailed discussion of Asahina and his work, with some previously unfamiliar photographs (and list of the new names he introduced).

This Dr Ikoma wrote "for the young men for studying the lichenological affairs (so this book is written in Japanese) but the details of History has not appeared, so I wrote this" (Y. Ikoma in litt., with English corrections) This is clearly something that all aspiring Japanese lichenologists will benefit from dipping into and be fascinated by, providing a personal impression of the characters as well as a scientific assessment of the contributions of different workers.

Flechten Japans. By A. Yasuda. 1925 [Reprinted 2002]. Y. Ikoma, Teramachi 45, Tottori City, Japan. Pp. 132, plates 25. ISBN not indicated. [In Japanese.] Price: ¥ 10 000.

Yasuda's work was originally written in German in 1923 but was lost in the Kanto earthquake that year, and Yasuda died in 1924. Yasukio Asahina gathered together a proof copy and translated it into Japanese, but few copies are available. This is a reprint of the Asahina translation, first published by The Saito Gratitude Foundation, Sendai, in 1925. The text is in Japanese with scientific names, and accompanied by copies of the original 25 half-tone plates in a separate envelope. This is the first time this work has ever really become available to the scientific community at large and will be of interest to lichenologists working on taxa Yasuda treated.

Lichenes Pertusariales*: *Coccotremataceae, Megasporaceae, Pertusariaceae. By María Inés Messuti & Gernot Vobis. January 2003 ['2002']. Consejo Nacional de Investigaciones Científicas y Técnicas de la República Argentina, Buenos Aires, Argentina. [Distributor: Koeltz Scientific Books, Herrnwaldstrasse 6, D-61462

Königstein, Germany.] [Flora Criptogámica de Tierra del Fuego Vol. 13(13).] Pp. 106, pl. 5. ISBN 950 9859 83 4. Price: € 40, US $ 46.

This revision covers species in the genera *Coccotrema* (5 spp.), *Lepolichen* (1 sp.), *Megaspora* (1 sp.), *Ochrolechia* (5 spp.), and *Pertusaria* (17 spp.). Keys, descriptions, details of ecology and distribution, and synonymy are provided, together with half-tone habit photographs of all 29 accepted species. No new scientific names are introduced, new taxa already found in the course of the study having already been published separately. A further 18 names reported are discussed but not accepted for various reasons. The discussions are detailed and I was pleased to see lists of specimens examined included (drawn from 29 herbaria). The bibliography seems comprehensive as regards records for the region. However, I was surprised not to see at least ascospore outlines and schematic diagrams of ascoma types included in view of their fundamental importance in the order. The taxonomy at the generic level is somewhat conservative in the light of recent molecular studies, which show that *Pertusaria* in particular is not monophyletic, but this does not invalidate the species concepts adopted which are the primary concern in floristic studies.

It is pleasing to see this work being authored by lichenologists based in the region, and also marking the return of the second author to the field after a long sojourn with the actinomycetes.

This is a valuable continuation of this important series, although the use of '*Lichenes*' as a group name has long been obsolete, irritates, and still needs to be addressed by the series editors.

Index of Type Specimens of Lichens preserved in the National Science Museum, Tokyo. By Hiroyuki Kashiwadani & Syo Kurokawa, March 2003. National Science Museum, Tokyo, Japan. Pp. 148. ISBN and Price: Not indicated.

The National Science Museum in Tokyo (TNS) is the most important lichen herbarium in Japan. Although the lichen collection was established only in 1962 by Syo Kurokawa, it now holds about 140 000 specimens, including some 30 000 collections of the herbarium of Yasuhiko Asahina. This publication details the 978 type specimens in the collection, providing the places of valid publication of the names, the kind of type, and the label details - transliterated to Roman script when the original was in Japanese. The entries are arranged alphabetically by the original scientific names, and include types in exsiccates of which the museum has sets. There is no doubt that this will save those wishing to locate the original material of Japanese lichen names considerable time, and increase the accessibility of the museum's holdings.

Atlas of the Geographical Distribution of Lichens in Poland. Part 3. Edited by Urszula Bielczyk, Stanisław Cieśliński & Wiesław Fałtynowicz. October 2002. Władysław Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31 512, Kraków, Poland. Pp. 114. ISBN 83 85444 93 9. Price € 25.

This part, the first to have appeared since 1999, covers 20 species belonging to 15 genera: *Acarospora, Anema, Caloplaca, Catillaria, Cyphelium, Diploschistes, Fuscopannaria, Micarea, Nephroma, Pannaria, Peccania, Psorotichia, Rinodina, Solorina,* and *Umbilicaria.* As in the companion series on non-lichenized fungi, detailed discussions are followed by maps with records indicated by date category and lists of specimens examined and literature sources. However, a significant and welcome difference is the continued provision of English as well as Polish versions of the discussions side by side – something that can only increase the accessibility of the included data.

The labelling of the *Atlas* as a third part of a series that started in 1993, however, scarcely does credit to the nine fascicles of the *Atlas of Geographical Distribution of Spore-*

Plants in Poland (1971-1988). Fortunately, this 'third part' does include an index of the species treated in the earlier nine volumes of its predecessor *Atlas*.

As the series covers more and more species, it will become increasingly valuable to lichenologists within and outwith the country. The authors and editors are to be congratulated on what has been achieved to date, and encouraged to cover yet further species in such excellent detail in the future.

Conidial Fungi

***Leptographium* Species: Tree pathogens, insect associates, and agents of blue-stain.** By Karin Jacobs & Michael J. Wingfield. 2001. APS Press, 3340 Pilot Knob Road, St Paul, MN 55121-2097, USA. Pp. xiv + 207, figs 156. ISBN 0 89054 278 3. Price: US $ 69.

Despite their importance as tree pathogens and agents of blue wood-stain, there has been no world monograph of the genus available. However, this is much more than a synthesis of what is known, for, as pointed out by Keith Seifert in the book's Foreword, the authors "have been most tenacious in their exploration of the globe for undiscovered *Leptographium* species, . . ". Of the 46 species treated, 31 have been described as new by the authors alone or with others in different publications.

The monograph starts with an overview, discussions of similar genera, associated synnematous synanamoprhs, and *Ophiostoma* teleomorphs, diseases, associated insects (with a table including references to all original sources), host trees (with a similar table), biogeography, methods of isolation, culture and preservation, and genetic methods. After a discussion of terms and how they are employed (e.g. including the conidiogenous cells *within* the conidiophore), both dichotomous and synoptic keys are provided – including ones to the teleomorphs.

Each species is provided with detailed descriptions, information of hosts, associated insects, lists of specimens examined, and first-rate line drawings, and superb light and cryo-scanning electron micrographs. Six excluded or dubious species are discussed, which could not be certainly placed as type material or cultures could not be located.

Three names in *Leptographium,* for which *Ophiostoma* teleomorphs had already been named, are indicated as "sp. nov.": *L. brevicolle, L. franke-grosmanniae,* and *L. leptographoides*). None of these names appear to be validly published as no Latin diagnosis was located nor a designated type for just the anamorphosis. I would have preferred to see just the *Ophiostoma* name alone used, as to introduce names for anamorphs where teleomorphs are known is contrary to the spirit of Art. 59 of the *Code*. After all, the authors did use the *Ophiostoma* names first in their arrangement!

This carefully executed and well-presented monograph is sure to remain the standard work on these fungi for many decades, even though the discovery and description of further species is sure to be stimulated by it. The authors indicate that it represents the results of studies over some 20 years, and the quality of the result certainly reflects this and demonstrates again the value of long-term monographic studies in mycology.

Taxonomy and Pathology of *Cylindrocladium* (*Calonectria*) and allied Genera. By Pedro W. Crous. 2002. APS Press, 3340 Pilot Knob Road, St Paul, MN 55121-2097, USA. Pp. xv + 278, figs 320. ISBN 0 89054 290 2. Price: US $ 69.

This superbly researched and presented monograph blends traditional morphomycology with molecular systematics, biochemistry, and plant pathology. Following detailed discussions of the diseases caused and well-illustrated accounts of how to isolate and study these fungi, the results of molecular and other biochemical approaches are presented as a prelude to the systematic treatment. This starts with keys to the anamorphs in the group, first to the genera and then to the species. The species keys have helpful marginal line drawings of the vesicles, which terminate the conidiophores in these fungi and prove to be of immense value in their separation. The teleomorphs in these hypocrealean fungi have clearly evolved less distinctive features than their anamorphs, indeed the author notes that the "teleomorphs . . . would be difficult if not impossible to distinguish without knowledge of their respective anamorphs". This begs the question as to whether subgeneric divisions of a single teleomorph might have been a more prudent taxonomic conclusion, but that is an issue best left for debate elsewhere.

In total, 54 species are accepted in five genera in this monograph: *Cylindrocladium* (39 spp.; 28 with *Calonectria* teleomorphs), *Curvicladium* (1 sp.), *Cylindrocladiella* (8 spp.; two with *Nectricladiella* teleomorphs), *Gliocladiopsis* (1 sp.; teleomorph *Glionectria*), and *Xenocylindrocladium* (1 sp.; teleomorph *Xenocalonectria*). Three new combinations are made, and three new species names introduced. Two of the latter are names proposed for anamorphs where the teleomorphs in *Calonectria* are known, and so quite unnecessary!

The species accounts include nomenclatural information on both anamorph and teleomorph (where known), references to published illustrations, a description, details of cultural characteristics, symptoms of diseases caused, hosts and distribution (with maps), type material and cultures studied, pertinent notes, and both excellent line drawings and unfortunately often too dark photomicrographs. An extensive bibliography, perhaps too-short glossary, and both host and fungal names indices conclude the work.

Notwithstanding differences in approach to the naming of anamorphs and teleomorphs, this is a most impressive contribution destined to be of lasting value to both mycologists and plant pathologists, and is made available at a most reasonable price.

ERRATA

VOLUME EIGHTY-FIVE

The photographs below were numbered incorrectly. Renumber as shown.

Page 291, top left	for	**1**	read	**4**
Page 291, top right	for	**2**	read	**3**
Page 291, lower left	for	**3**	read	**2**
Page 291, lower right	for	**4**	read	**1**

VOLUME EIGHTY-EIGHT

Cover 2, 4th line from bottom	for	*Cltocybe*	read	*Clitocybe*
Page 235, line 11	for	FIGURES 2–9	read	FIGURES 1–9
Page 235, last line	for	*ciocCeras*	read	*crioceris*

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(continued from inside front cover)

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As deadlines are wont to do, my first press deadline arrived too soon. We (i.e., I) thought that this first effort could easily be printed almost entirely from author-submitted digital files. Unfortunately, "we" were wrong. Volume 89(1) is thus an amalgam of [i] photographed author-submitted hard copy, [ii] photographed pages printed by the Editor from author digital files, and – possibly – [iii] digital files printed directly by Sheridan Press from the editorial CDs. The authors, who remained remarkably patient and receptive to over-enthusiastic changes from a novice editor, have served as most agreeable guinea-pigs ["conejillos de indias" according to one good-humored correspondent]. Such cordial authors and subscribers deserve the best. I can only hope to serve fungal taxonomy and taxonomists as well as the editors of *Mycotaxon's* first three decades.

LORELEI L. NORVELL
***Mycotaxon** Editor-in-Chief*
February 29, 2004

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MYCOTAXON

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TAXONOMY & NOMENCLATURE OF FUNGI, INCLUDING LICHENS

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MYCOTAXON

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Glomus insculptum, a new arbuscular mycorrhizal species from Poland

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Abstract–A new ectocarpic arbuscular mycorrhizal fungal species, *Glomus insculptum* (Glomerales, Glomeromycota), was found in inland sand dunes of southern Poland. *Glomus insculptum* produces yellow-colored spores that are globose to subglobose, (50-) 71(-85) μm diam, or ovoid, 55—60 x 80—85 μm, and have a spore wall composed of two layers. The outer layer is permanent and the inner layer is laminate and ornamented with round pits evenly distributed on its inner surface. *Glomus insculptum* forms arbuscular mycorrhizae in single-species pot cultures with *Plantago lanceolata*.

Key Words–Glomeromycota, mycorrhizae, new species

Introduction

The largest inland sandy area of Poland is the Błędowska Desert (Szczypek & Wika 1984). It is located in the eastern part of Silesia Upland (50°22' N, 19°34'E) and occupies 30 km^2. The unique plant communities of the Błędowska Desert are phytocenosis of inland sandy dunes and xerothermic swards with original psammophytic species. *Corynephorus canescens* (L.) P. B., *Elymus arenarius* L., and *Koeleria glauca* (Schkuhr) DC. are the dominant plant species in the dunes (Mrozik & Wika 1993).

Apart from 20 described species of arbuscular mycorrhizal fungi of the phylum Glomeromycota, examination of rhizosphere soil samples collected under plants of the Błędowska Desert in the years 1995-1997 revealed a new species of *Glomus* forming spores with pitted inner surface of their laminate spore wall layer (Błaszkowski et al. 2002). Subsequent culturing of this fungus in both trap and single-species cultures confirmed the uniqueness of this as a new species. The fungus is described here as *Glomus insculptum*.

Materials and Methods

Collection of soil samples, establishment of trap and single-species pot cultures, as well as growth conditions generally are as those described previously (Błaszkowski & Tadych 1997). Briefly, rhizosphere soils and roots of sampled plants were collected from a depth of 5-30 cm using a small garden shovel. In the laboratory, about 200-g subsamples were taken from each sample to determine the species of arbuscular fungi sporulating in the field. Then, the remaining soil-root mixtures were either air dried for 2 weeks and subsequently refrigerated at 4°C or directly used to establish trap cultures. Trap cultures were established to obtain a great number of living spores of different developmental stages and to initiate sporulation of species that were present but not sporulating in the field collections. The growing substrate of the trap cultures was the field-collected material mixed with an autoclaved coarse-grained sand coming from maritime dunes adjacent to Świnoujście (pH 6.7; 12 and 26 mg L^{-1} P and K, respectively; Błaszkowski 1995). These mixtures were placed in 9x12.5-cm plastic pots (500 cm^3) and thickly seeded with *Plantago lanceolata* L. Plants were grown in a greenhouse at 15-30°C with supplemental 8-16-h lighting provided by one SON-T AGRO sodic lamp (Philips Lighting Poland S. A.) placed 1 m above pots. The maximum light intensity was 180 μE $m^{-2}s^{-1}$ at pot level. Plants were watered 2-3 times a week. No fertilizer was applied during the growing period. Trap cultures were harvested at approximately 1-month intervals, beginning three months and ending five to seven months after plant emergence. Spores were extracted by wet sieving and decanting (Gerdemann & Nicolson 1963). Presence of mycorrhizae was determined following clearing and staining of roots (Phillips & Hayman 1970) modified as follow: tissue acidification with 20% HCl instead of 1%, and trypan blue concentration 0.1% instead of 0.05% (Koske, pers. comm.).

Single-species pot cultures were established from about 50 to 100 newly formed spores stored before inoculation in water at 4°C for 24 h. After removal of soils debris, spores were collected in a pipette and transferred onto a compact layer of mycorrhizae-free roots of 10-14-day-old seedlings of *P. lanceolata* placed at the bottom of a hole of *ca.* 1 cm wide and 4 cm deep formed in a wetted growing medium filling 8-cm plastic pots (250 cm^3). The growing medium was an autoclaved sand of maritime dunes adjacent to Świnoujście with chemical properties listed above. Subsequently, the spores were covered with another layer of roots attached to 4-6 additional host plants, and the roots and sandwiched spores were buried in the growing medium. Finally, three to six seeds of *P. lanceolata* were placed on the surface of the growing substrate and covered with a thin layer of autoclaved sand. The cultures were harvested after 4-8 months and spores extracted. The effectiveness of the method of establishment of one-species cultures described above usually exceeded 90% (Błaszkowski et al. 2002).

Morphological properties of spores and their subcellular structures were determined based on at least 100 spores mounted in polyvinyl alcohol/lactic acid/glycerol (PVLG; Koske & Tessier 1983) and a mixture of PVLG and Melzer's reagent (1:1, v/v). Spores in all stages of development were crushed to varying degrees by applying pressure to the coverslip and then stored at 65°C for 24 h to clear their contents of oil droplets. These were examined under an Olympus BX 50 compound microscope equipped with Nomarski differential interference contrast optics. Microphotographs were captured in a Sony 3CDD color video camera coupled to the microscope.

Terminology of spore structure is that suggested by Spain et al. (1989), Stürmer & Morton (1997), and Walker (1983). Spore color was examined under a dissecting microscope on fresh specimens immersed in water. Color names are from Kornerup & Wanscher (1983). Nomenclature of fungi and plants is that of Walker & Trappe (1993) and Mirek et al. (1995), respectively. Specimens were mounted in PVLG on slides and deposited in the Department of Plant Pathology (DPP), University of Agriculture, Szczecin, Poland, and in the herbarium at Oregon State University (OSC) in Corvallis, Oregon, USA.

Color microphotographs of spores and mycorrhizae of *G. insculptum* can be viewed at the URL http://www.agro.ar.szczecin.pl/~jblaszkowski/.

Descriptions of the species

Glomus insculptum J. Błaszkowski, sp. nov. **Figs. 1-10**

Sporocarpia ignota. Sporae singulatim in solo vel in radici, e sporophoris rectic efformatae. Sporophorum nonseptatum vel parce septatum; hyalinum; (3.7-)4.8(-5.6) μm latum; pariete 0.3-0.5 μm crasso; rectum. Sporae pallide luteae vel aureae; globosae vel subglobosae; (50-)71(-85) μm diam; aliquando ovoideae; 55-60 x 80-85 μm; hypha subtenda solitaria. Tunica sporae e startis duobus (strati 1-2); strato "1" rigido, diuturno, glabro, hyalino vel pallide luteo, (0.9-)1.1(-1.5) μm crasso; strato "2" laminato, pallide luteo vel aureo, (3.2-)4.4(-6.1) μm crasso cum superficie interia cum orbicularis cavernis ordinatis, (1.2-)1.6(-2.0) μm diam, 1.2—2.0 μm profundis. Hypha hyalina; recta vel recurva; cylindrica vel infundibuliforma, raro coliga; (2.9-)5.2(-6.9) μm lata ad basim sporae; pariete hyalino; (0.7-)1.3(-2.9) μm crasso, stratis 1-2 sporae continuo. Porus e septo continuo strati 2 sporae efformata. Arbuscular mycorrhizae formans.

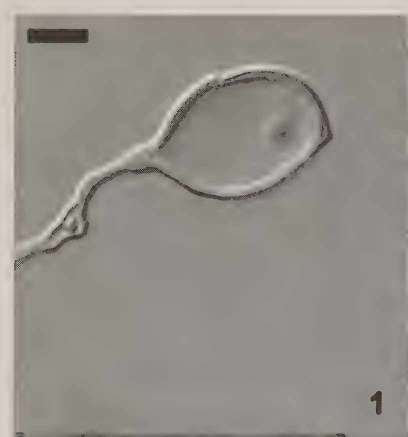
Sporocarps unknown. Spores borne singly in the soil (Figs. 1, 2); produced from straight sporophores (Figs. 1-7). *Sporophore* coenocytic to sparsely septate; hyaline; (3.7-)4.8(-5.6) μm wide; with a wall 0.3—0.5 μm thick; bearing spores by swelling at hyphal tips (Fig. 1)._*Spores* yellowish white (2A2) to golden yellow (5B8); globose to subglobose; (50-)71(-85) μm diam; sometimes ovoid; 55-60 x 80-95 μm; with a single subtending hypha (Fig. 1-3, 7). Subcellular structure of spores consists of one wall with two layers (swl 1-2; Figs. 3-7). Outermost layer 1 permanent, smooth or with a slightly roughened outer surface, hyaline, ca. 0.5 μm thick, continuous with a one-layered subtending hypha of the most juvenile spores (Fig. 1), then darkening to pale yellow (3A3) and thickening to (0.9-)1.1(-2.7) μm (Figs. 3-7). Layer 2 laminate, yellowish white (2A2) to golden yellow (5B8), (3.2-)4.4(-6.1) μm thick, with a smooth outer surface and an evenly pitted inner surface (Figs. 3-6); pits round, (1.2-)1.6(-2.0) μm diam (Figs. 3-5), 1.2-2.0 μm deep, separated by ridges, (0.7-)1.1(-1.7) μm wide (Figs. 4, 6); in the most juvenile spores, the inner surface is frequently smooth; in young (immature) spores, it contains shallow pits that may be difficult to see (Figs. 6, 7). No spore wall layers react in Melzer's reagent.

Subtending_hypha hyaline to pale yellow (3A3); straight or recurved; cylindrical or slightly flared (Figs. 3, 7), rarely constricted; (2.9-)5.2(-8.5) μm wide at the spore base, consisting of two layers (shwl 1 and 2) continuous with spore wall layers 1 and 2 (Fig. 7); layer 2 of spore wall is highly thinned at the spore base and then either further thins to 0.7 μm or forms a recurved septum, 1.5-2.7 μm wide and 0.5—0.7 μm thick, positioned 1.0—6.0 μm in the hyphal lumen (Fig. 7).

Etymology. Latin, *insculptum*, referring to the pitted inner surface of the laminate spore wall layer 2.

Specimen examined: HOLOTYPE: Poland. Szczecin, associated with roots of pot-cultured *P. lanceolata*, 25 June 1999, *Błaszkowski, J., 2271* (DPP); ISOTYPES: *Błaszkowski, J.*, 2272-2309 (DPP) and two slides at OSC.

Figs. 1-10. Spores and mycorrhizae of *Glomus insculptum* in roots of *Plantago lanceolata* stained in 0.1% trypan blue. **1.** Young spore. **2.** Mature spores. **3.** Spore wall layers 1 (swl1) and 2 (swl2), pits (p) on the inner surface of spore wall layer 1, and subtending hypha (sh). **4.** Spore wall layer 1 (swl1) separated from pitted spore wall layer 2 (swl2). **5.** Spore wall layers 1 (swl1) and 2 (swl2) with pits (p) seen through the spore surface. **6.** Spore wall layer 1 (swl1) and pits of spore wall layer 2 (pswl2) seen in a cross-sectional view. **7.** Spore wall layers 1 (swl1) and 2 (swl2) continuous with subtending hyphal wall layers 1 (shwl1) and 2 (shwl2); septum (s) of the subtending hypha is visible. **8.** Arbuscule (arb) with its poorly visible trunk (tr). **9.** Coils of intraradical hyphae. **10.** Coiled (chyp) and straight (shyp) intraradical hyphae. Figs. 1, 3, 4, 6, 7, spores crushed in PVLG + Melzer's reagent. Fig. 2, spores in water. Fig. 5, spore crushed in PVLG. Figs. 8-10, roots in PVLG. Figs. 1 and 3-10, differential interference contrast; Fig. 2, bright field microscopy. Bars: Figs. 1 and 3-10=10 μm, Fig. 2=50 μm.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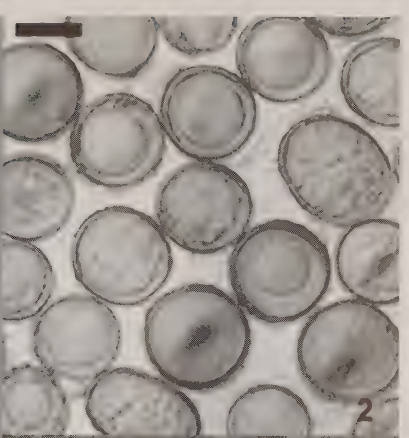
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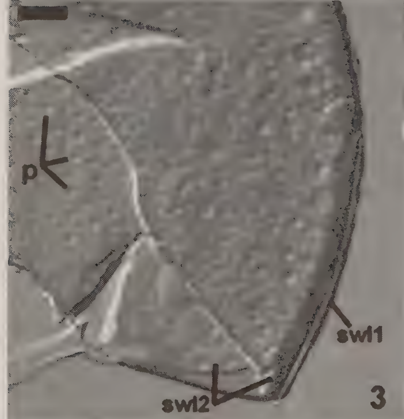
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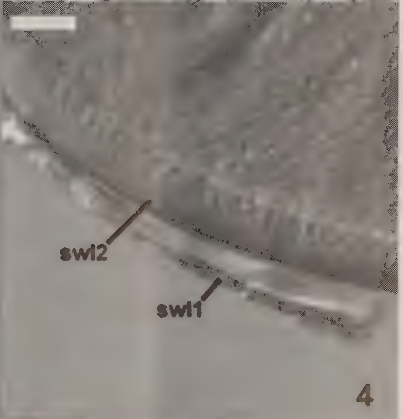
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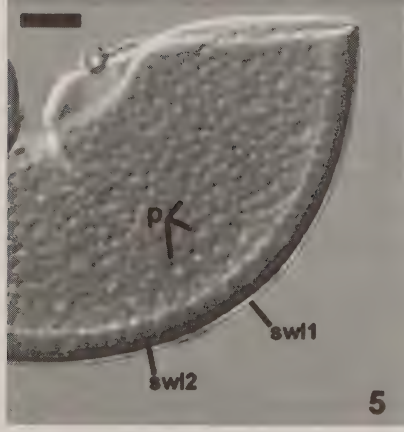
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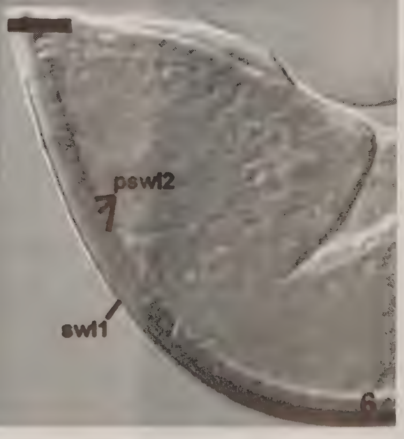
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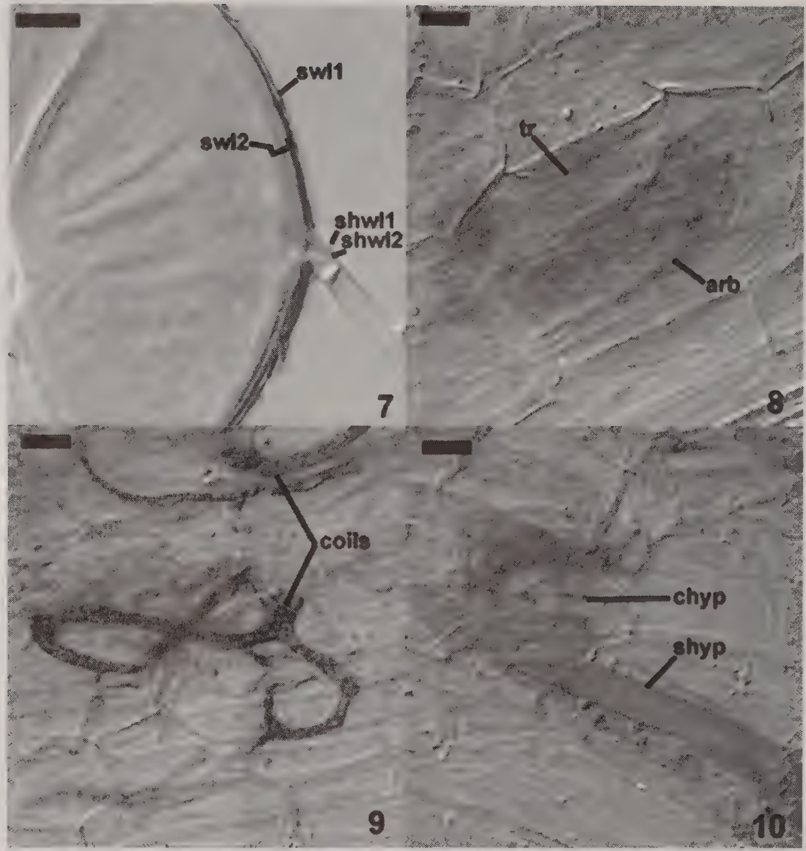

Other materials examined. Poland. The Błędowska Desert (50°22' N, 19°34' E), from the root zone of *Corynephorus canescens* (L.) P. Beauv., *Festuca rubra* L. s. s., *Holcus mollis* L. and *Juniperus communis* L., 26 June 1997, *Błaszkowski, J.*, unnumbered collection (DPP). Spores from trap pot cultures established based on rhizosphere soils of the plant species listed above and from five other cultures with rhizosphere soils of the same plant species and *P. major* L., 2 Oct. 1999, *Błaszkowski, J.*, unnumbered collection (DPP).

Distribution and habitat. Spores of *G. insculptum* were isolated from seven field-collected soil samples and 10 trap pot cultures that were established with rhizosphere soils of five plant species colonizing inland sand dunes of the Błędowska Desert (50°22' N, 19°34' E) in south of Poland. The plant species colonized by *G. insculptum* in the field were *C. canescens,* *F. rubra, H. mollis, J. communis* and *P. major*. Spore abundance of *G. insculptum* in the field-collected samples ranged from 0 to 79 (mean 18) in 100 g dry soil. The arbuscular mycorrhizal fungal species richness in the soil samples containing *G. insculptum* ranged from 2 to 6 (mean 2.5) in 100 g dry soil. The fungi co-occurring with *G. insculptum* in the field were *Acaulospora lacunosa* Morton, *A. mellea* Spain & Schenck, *G. aggregatum* Schenck & Smith emend. Koske, *G. fasciculatum* (Thaxter) Gerd. & Trappe emend. Walker & Koske, *G. mosseae* (Nicol. & Gerd.) Gerd. & Trappe, and *Scutellospora dipurpurescens* Morton & Koske. The fungi accompanying *G. insculptum* in trap cultures were *A. lacunosa, Archaeospora trappei* (Ames & Linderman) Morton & Redecker, *G. clarum* Nicol. & Schenck, *G. intraradices* Schenck & Smith, *G. lamellosum* Dalpé, Koske & Tews, *G. pustulatum* Koske, Friese, Walker & Dalpé, two undescribed *Glomus* species., *Paraglomus occultum* (Walker) Morton & Redecker, *S. armeniaca* Błaszk., and *S. dipurpurescens*.

The soil chemical properties of the Błędowska Desert dunes ranged: pH, 5.6-5.9; NO_3 (mg L^{-1}), 9.3-10.8; P, 3-5; K, 5-13; Mg, 7-23; Na, 0-1; Cl, 13.7-18.2; KCl (g L^{-1}), 0.060-0.075; organic C (%), 0.27-0.42.

Mycorrhizal associations. In the field, *Glomus insculptum* occurred among vesicular-arbuscular mycorrhizal roots of *C. canescens*, *F. rubra*, *H. mollis*, *J. communis*, and *P. major*. Mycorrhizae of this fungus formed in one-species cultures with *P. lanceolata* as the plant host consisted of arbuscules, intra- and extraratrical hyphae. Arbuscules appeared as granular structures in cortical cells (Fig. 8). Fine branches were difficult to see. Arbuscules were numerous, but unevenly distributed in roots. The intraratrical hyphae were (4.2-)6.2(-7.4) μm wide and grew parallel to the root axis (Fig. 10). They were straight or slightly curved, sometimes dichotomously branched and frequently coiled (Figs. 9, 10); the coils were 20.8—34.6 x 10.5—22.3 μm. No vesicles were present in roots of plants up to 8-months-old. Extraradical hyphae were (1.7-)3.2(-3.5) μm wide and frequently associated with young and mature spores. In 0.1% trypan blue, arbuscules stained violet white (17A2), intramatrical hyphae violet white (17A2) to pastel violet (17A4), and extraradical hyphae pale violet (17A3).

Discussion

When observed under a dissecting microscope, spores of *G. insculptum* most resemble small-spored isolates of *G. aggregatum*, *G. arenarium* Błaszk. at al., *G, etunicatum* Becker & Gerd., *G. intraradices* Schenck & Smith, *G. pustulatum*, *G. trimurales* Koske & Halvorson, and *G. versiforme* (Karsten) Berch. All eight species form globose to subglobose and yellow-colored spores, whose size range partly overlaps (Becker & Gerdemann 1977; Berch & Fortin 1983; Błaszkowski 1991; Błaszkowski et al. 2001, 2003; Koske 1985; Koske & Halvorson 1989; Koske et al. 1986; Morton 2000; Schenck & Smith 1982; Stürmer & Morton 1997).

Examination of subcellular structure and phenotypic properties of layers in the spore wall of specimens crushed in Melzer's reagent readily separates these species. Only *G. insculptum* forms spores in which the laminate spore wall layer is regularly pitted (Figs. 3-6). However, in young spores, the inner surface either is smooth or the pits are very shallow and difficult to see (Figs. 6, 7). Even then, *G. insculptum* is distinguishable from other species. Although *G. etunicatum*, *G. insculptum*, and *G. versiforme* have a spore wall composed of two layers, the outer layer of each differs. In *G. etunicatum* the layer sloughs as spores mature (Stürmer & Morton 1997), while in *G. versiforme* it is semi-permanent (Morton 2000) and in *G. insculptum* it is permanent (Figs. 3-7). Additionally, the outer spore wall layer of *G. insculptum* and *G. versiforme* (Morton 2000) is nonreactive in Melzer's reagent but stains dark pinkish red to reddish-purple in *G. etunicatum* (Stürmer & Morton 1997). *Glomus versiforme* also differs from *G. insculptum* in the occasional production of spores arranged in epigeous sporocarps (Berch & Fortin 1983; Morton 2000) vs. only single, hypogeous spores in *G. insculptum* and in that the mean diameter of globose spores of the former fungus is almost twice that of spores of the latter species. In contrast to the two-layered subcellular spore wall structure of *G. insculptum* (Figs. 3-7), that of *G. arenarium*, *G. pustulatum*, and *G. trimurales* consists of three layers.

The only other species of arbuscular fungi forming spores with an ornamented inner surface of their innermost wall layer are *G. kerguelense* Dalpé & Strullu and *G. verruculosum* Błaszk. However, compared with *G. insculptum*, spores of the two species are much larger (mean diameter = 71 μm in *G. insculptum* vs. 186.3 μm and 189.0 μm in *G. kerguelense* and *G. verruculosum*, respectively) and the ornamentation of the innermost layer of their wall consists of fine granules (*G. kerguelense*) or warts (*G. verruculosum*; Błaszkowski & Tadych 1997; Dalpé et al. 2002) vs. pits in *G. insculptum.*

Acknowledgments

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Literature cited

Becker WN, Gerdemann JW. 1977. *Glomus etunicatus* sp. nov. Mycotaxon 6, 29-32.

Berch SM, Fortin JA. 1983. Lectotypification of *Glomus macrocarpum* and proposal of new combinations: *Glomus australe*, *Glomus versiforme*, and *Glomus tenebrosum* (Endogonaceae). Can. J. Bot. 61, 2608-2617.

Błaszkowski J. 1991. Polish Endogonaceae. IX. Glomus aggregatum with spores forming an evanescent outermost wall. Crypt. Bot. 2/3, 130-135.

Błaszkowski J. 1995. *Glomus corymbiforme*, a new species in Glomales from Poland. Mycologia 87, 732-737.

Błaszkowski J, Tadych M. 1997. *Glomus multiforum* and *G. verruculosum*, two new species from Poland. Mycologia 89, 804-811.

Błaszkowski J, Tadych M, Madej T. 2002. Arbuscular mycorrhizal fungi (Glomales, Zygomycota) of the Błędowska Desert, Poland. Acta Soc. Bot. Pol. 71, 71-85.

Błaszkowski J, Adamska I, Czerniawska B. 2003. Glomus trimurales, an arbuscular mycorrhizal fungus (Glomerales) new for Poland and Europe. Mycotaxon 87, 425-436.

Błaszkowski J, Tadych M, Madej T. 2001. *Glomus arenarium*, a new species in Glomales (Zygomycetes). Acta Soc. Bot. Pol. 70, 97-101.

Błaszkowski J, Adamska I, Madej T. 2002. *Glomus lamellosum* (Glomales, Zygomycota), an arbuscular mycorrhizal fungal species new for Poland and Europe. Mycotaxon 81, 281-292.

Dalpé Y, Plenchette C, Frenot Y, Gloaguen JC, Strullu DG. 2002. *Glomus kerguelense* sp. nov., a new Glomales species from sub-Antarctic. Mycotaxon 84, 51-60.

Gerdemann JW, Nicolson TH. 1963. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. Trans. Brit. Mycol. Soc. 46, 235-244.

Kornerup A, Wanscher JH. 1983. *Methuen handbook of colour*. 3rd edn. E. Methuen and Co., Ltd., London.

Koske RE. 1985. Glomus aggregatum emended: A distinct taxon in the Glomus fasciculatum complex. Mycologia 77, 619-630.

Koske RE, Halvorson WL. 1989. *Scutellospora arenicola* and *Glomus trimurales*: two new species in the Endogonaceae. Mycologia 81, 927-933.

Koske RE, Tessier B. 1983. A convenient, permanent slide mounting medium. Newsl. Mycol. Soc. Amer. 34, 59.

Koske RE, Friese C, Walker C, Dalpé Y. 1986. *Glomus pustulatum*: A new species in the Endogonaceae. Mycotaxon 26, 143-149.

Mirek Z, Piękoś-Mirkowa H, Zając A, Zając M. 1995. Vascular plants of Poland. A Checklist. Polish Botanical Studies, Guidebook 15, Kraków, 303 pp.

Morton JB. 2000. International Culture Collection of Arbuscular and Vesicular-Arbuscular Mycorrhizal Fungi. West Virginia University.

Mrozik A, Wika S. 1993. O ochronę biotopów Pustyni Błędowskiej. In: Szczypek T, Wika S (eds.). *Kształtowanie środowiska geograficznego i ochrona przyrody na obszarach uprzemysłowionych i zurbanizowanych* 8, 25-30.

Phillips JM, Hayman DS. 1970. Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Brit. Mycol. Soc. 55, 158-161.

Schenck NC, Smith GS. 1982. Additional new and unreported species of mycorrhizal fungi (Endogonaceae) from Florida. Mycologia 74, 77-92.

Spain JL, Sieverding E, Schenck NC. 1989. *Gigaspora ramisporophora*: a new species with novel sporophores from Brazil. Mycotaxon 34, 667-677.

Stürmer SL, Morton JB. 1997. Developmental patterns defining morphological characters in spores of four species in *Glomus*. Mycologia 89, 72-81.

Szczypek T, Wika S. 1984. Wpływ wiatru i działalności człowieka na krajobraz Pustyni Błędowskiej. Wszechświat 85, 137-139.

Walker C. 1983. Taxonomic concepts in the Endogonaceae: Spore wall characteristics in species descriptions. Mycotaxon 18, 443-455.

Walker C, Trappe JM. 1993. Names and epithets in the Glomales and Endogonales. Mycol. Res. 97, 339-344.

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A new aquatic nematode-trapping hyphomycete

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Abstract—A new *Dactylella* species was isolated during a survey of aquatic fungi on submerged wood in Dianchi Lake, Kunming, Yunnan Province, China. Its simple and branched conidiophores form a few short branches or spurs near apex and produce 2–3 conidia in sympodial arrangement. Conidia are hyaline, spindle or clavate, round at the distal end, truncate at the base, 1–7-septate, mainly 2-5-septate, 37.5–100.0 (70.0) X 10.0–17.5 (14.3) μm.

Keywords—aquatic hyphomycete, *Dactylella dianchiensis*., nematode-trapping fungi

Introduction

Nematode-trapping fungi are usually isolated from rotten plant debris and soil. Their distribution on waterlogged soil or submerged wood is rarely mentioned in research literature. Only seven species of predacious hyphomycetes from an aquatic environment have been recorded (Ingold 1944, Peach 1950 and 1952, Nakagiri 1991). Recently, a survey of the fungi on submerged wood and waterlogged soil in Dianchi Lake was conducted. The methods used for the survey were to place wood samples into zipped plastic bags with waterish filter papers and to sprinkle soil samples onto CMA agar challenged with the free-living nematode, *Paragrellus redivius*. After incubation for 1–4 weeks at 25°C, the samples were examined under a dissecting microscope. A *Dactylella* species was isolated from the submerged wood and several recorded nematode-trapping fungi such as *Arthrobotrys oligospora* Fres, *A. conoides* Drechsler, *Monacrosporium elegans* Oudem, *M. thaumasium* (Drechsler) de Hoog & van Oorschot, *M. sphaeroides* Castaner, *M. cystosporium* Cooke & Dickinson and

Dactylella leptospora Drechsler were isolated from the waterlogged soil. After a study of the morphological characteristics of the *Dactylella* species and a survey of the literature (Ingold 1944, Dowsett et al. 1984, Watanabe 1992, Liu & Qiu 1993, Zhang, Liu & Cao 1994, Rubner 1996, Nakagiri & Tadeyoshi 1996, Miao et al. 1999), we believe that this fungus is an undescribed species and name it *Dactylella dianchiensis*.

We follow the traditional view that the genera *Arthrobotrys, Dactylella* and *Monacrosporium* are distinguished by conidia with or without the largest cell, conidia septa, shape and size and conidiophores knotted or producing solid conidia, which has been widely accepted (Cooke & Dickinson 1965, Castaner 1968, Scheuck et al. 1977, Van Oorschot 1985, Zhang et al. 1994, Rubner 1996, Li & Miao et al. 2003, Liu & Zhang 2003). We therefore place the new fungus into *Dactylella* rather than *Arthrobotrys*, which has been amended by Schaller et al. (1999), who considered that *Arthrobotrys* forms adhesive networks. The detailed morphological characteristics of the new species are described in comparison with those of its similar species.

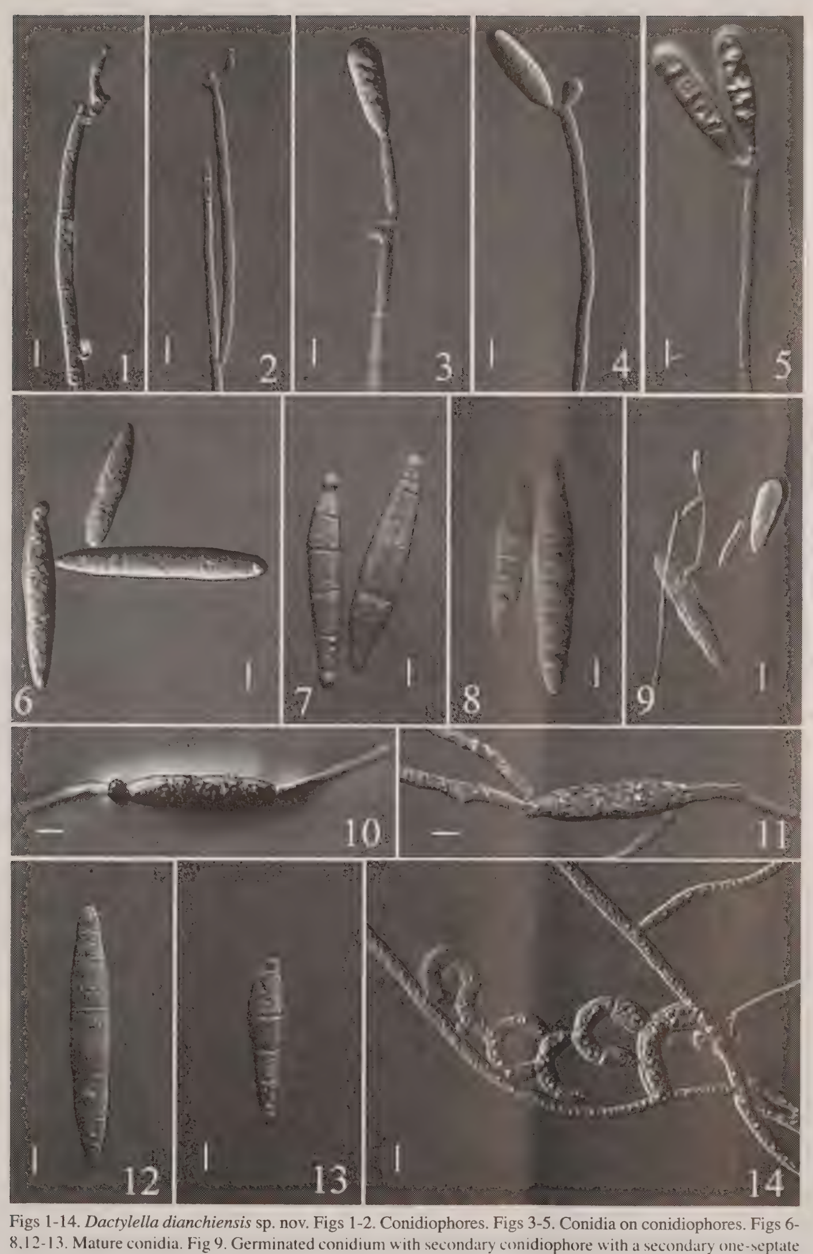
Dactylella dianchiensis Y. E. Hao et K. Q. Zhang sp. nov. (Figs 1-14)

Etym.: The species *Dactylella dianchiensis* was named after Dianchi Lake, Kunming, Yunnan Province, China, where it was first isolated.

Coloniae in agaro CMA albidae, post 6 dies 25°C 6 cm diam. Mycelium sparsum, hyphis septatis, ramosis, 2.5–5 μm latis, trimensionis formantibus. Conidiophora erecta simplex vel ramosa, 2–4 septata, 245–425 μm longa, 5–7.5 μm lata ad basim, 2.5–5 μm lata ad apicem. Conidia hyalina, fusiformis vel clavata, conidia e tuberculis geminate. 1–7 septata, praecipue 2–5 septata. Conidia secundaria clavatia, plerumque 1 septata, vulgo circa 23.9 μm longa et 5 μm lata. Habitat in ligno submerse.

Holotype: YMF1.00571D, Dianchi Lake, Kunming, Province Yunnan, China, 10-II-2003, Jing Luo. The holotype and its culture (YMF1.00571) are deposited in the Key Laboratory of Microbial Fermentation, Yunnan University.

A single spore was inoculated on PDA, a colony reached 7 cm in diameter at 28°, 5 cm at 25°C and did not grow at –4°C or 35°C within 4 days. The colony was initially whitish and turned orange white after 10 days of incubation. At the same time the reverse side of the media became faintly yellow to reddish orange. Colonies on CMA whitish, rapidly- growing and extending a diameter of 6 cm at 25°C within 6 days. Mycelium hyaline, scanty, hyphae septate, branched, 2.5–5 μm wide. Primary conidiophores (Figs 1-5) erect, simple or branched, 2–4-septate, 245–425 μm high, 5–7.5 μm wide at the base, gradually tapering upward to



Figs 1-14. *Dactylella dianchiensis* sp. nov. Figs 1-2. Conidiophores. Figs 3-5. Conidia on conidiophores. Figs 6-8,12-13. Mature conidia. Fig 9. Germinated conidium with secondary conidiophore with a secondary one-septate conidium attached. Figs 10-11. Germinated conidia. Fig 14. Adhesive network. bar=10 μm.

a width of 2.5–5 μm at the tip, initially a width of 2.5–5 μm at the tip, later often producing a few short branches or spurs near the apex, and bearing 2-3 conidia in sympodial arrangement. Primary conidia (Figs 6, 8, 12) hyaline, spindle or clavate, narrowly round at the distal end, truncate at the base, 37.5–100.0 (70.0) X10.0–17.5 (14.3) μm, 1-7-septate, mainly 2-5-septate. The proportion of conidia with 1, 2, 3, 4, 5, 6 and 7 septa was 10.0%, 17.1%, 14.3%, 24.3%, 21.4%, 8.6% and 4.3% respectively. Some primary conidia had small tubercles at both ends (Figs 7, 13) and could germinate from these tubercles (Fig 10).The primary conidia could produce secondary conidiophores and secondary conidia (Fig 9). The secondary conidia spindle-shaped, about 23.9 X 5 μm, with 1 septum. Capturing nematodes by simple adhesive networks (Fig 14).

Table 1. Morphological comparison of *Dactylella dianchiensis, D. iridis (Trinacrium iridis, D. ramiformis)*[1], *D. crassa,* and *D. multiformis*

SPECIES	SIZE OF PRIMARY CONIDIA	NUMBER OF PRIMARY CONIDIAL SEPTA
D. dianchiensis	37.5–100.0 (70.0) X 10.0–17.5 (14.3) μm	1-7 (mainly 2-5)
D. iridis	47.5–155.0 X 7.5–16.3 μm	4-10
D. crassa	44.5–60 X 10–13 μm	1-5 (mainly 3-4)
D. multiformis	35–90.3 X 4–7.5 μm	4-12

[1] *Trinacrium iridis* (Watanabe 1992) and *Dactyllela ramiformis* (Liu & Qiu 1993) are synonyms of *Dactyllela iridis* (Nakagiri & Tadeyoshi 1996, Rubner 1996).

Dactylella dianchiensis is distinguished from *D. iridis* (Zhang, Liu & Cao 1994), *D. crassa* (Miao, Lei & Liu 1999) and *D. multiformis* (Dowsett, Reid & Kalkat 1984) by the size and septation of primary conidia (table 1), although it resembles those fungi in primary conidial shape and traps nematodes by means of the three-dimensional adhesive networks. *D. dianchiensis* produces conidia with small tubercles at both ends and without any branches, while *D.iridis* produces some branched conidia. Another similar species, *D. submerse* (Ingold 1944), does not produce any trapping devices.

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Literature Cited

Castaner D. 1968. A conidiobolus-like fungus destroying nematode in Iowa. Mycologia 60:440-443.

Cooke RC, Dickinson CH. 1965. Nematode-trapping species of *Dactylella* and *Monacrosporium*. Trans. Brit. Mycol. Soc. 48:621-629.

Dowsett JA, Reid J, Kalkat.RS 1984. A new species of *Dactylella*. Mycologia 76: 563-566.

Ingold CT. 1944. Some new aquatic hyphomycetes. Trans. Brit. Mycol. Soc. 27:45-46.

Li SD, Miao ZQ, Zhang YH, Liu XZ. 2003. *Monacrosporium janus* sp. nov., a new nematode-trapping hyphomycete parasitizing sclerotia and hyphae of *Sclerotinia sclerotiorum*. Mycol. Res. 107(7):888-894.

Liu XF, Zhang KQ. 2003. *Dactylella shizishanna* sp. nov., from Shizi Mountain, China. Fungal Diversity 14:103-107.

Liu XZ, Qiu WF. 1993. A new species of *Dactylella* from China. Mycol. Res. 97(3): 359-362.

Miao ZQ., Lei LP, Liu XZ. 1999. *Dactylella crassa*, A new species of nematode-trapping fungi. Mycosystema 18: 354-356.

Nakagiri A, Tadeyoshi L. 1996. Taxonomy and ecology of *Dactylella iridis*: its redescription as an entomogenous and nematode-capturing hyphomycete. Mycoscience 37:81-89.

Nakagiri A. 1991. A new *Trinacrium*-like aquatic hyphomycete with predacity for nematode. Proc. 35th Ann. Meet. Mycol.Soc.Japan (Abstract) 55

Peach M 1950. Aquatic predacious fungi. Trans. Brit. Mycol. Soc. 33:148-153.

Peach M. 1952. Aquatic predacious fungi II. Trans. Brit. Mycol. Soc. 35:19-23.

Rubner A. 1996. Revision of predacious hyphomycetes in the *Dactylella-Monacrosporium* complex. Stud. Mycol. 39:1-134.

Schenck S, Kendrick WB, Pramer D. 1977. A new nematode-trapping species and a revaluation of *Dactylaria* and *Arthrobotrys*. Can. J. Bot. 55:977-985.

Van Oorschot CAN. 1985. Taxonomy of the *Dactylaria* complex. V. A review of *Arthrobotrys* and allied genera. Stud. Mycol. 26:61-96.

Watanabe T. 1992. *Trinacrium iridis*. sp.nov. from iris roots in Japan. Mycologia 84:794-798.

Zhang, KQ, Liu, XZ., Cao L. 1994. A review of *Dactylella* and a new species. Mycosystema 7:111-118.

MYCOTAXON

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Notes on dictyosporic hyphomycetes from China IV. The genus *Berkleasmium*

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Abstract—Two new species and a new Chinese record of the genus *Berkleasmium* are reported. They are *B. atrovirens* and *B. taishanense*. The new record for China is *B. inflatum*. Latin diagnoses, English descriptions and illustrations of the two new species are presented. The specimens studied were deposited in the Herbarium of Shandong Agricultural University: Plant Pathology (HSAUP).

Key words— *Berkleasmium atrovirens, Berkleasmium taishanense*

Introduction

Zobel (1854) erected *Berkleasmium* with *B. cordaeanum* Zobel as its type. However, *B. cordaeanum* is a synonym of *Sporidesmium concinnum* Berkeley (1845). Saccardo (1882) included the fungus as a species of *Sporidesmium* Link ex Fr. (1809). Moore (1958, 1959) reassessed *Sporidesmium*, and the genus *Berkleasmium* was retrieved for certain sporodochial deuteromycetes that had been described in *Sporidesmium* (sensu Saccardo). *Berkleasmium concinnum* (Berk.) Hughes (1958) is the correct name of type species of the genus. Subsequently at least 10 species were assigned to the genus, which produces phaeodictyospores acrogenously on short, simple conidiophores, or else are sessile with sporodochial conidiomata. This genus is reported for the first time from China.

Taxonomic Description

Berkleasmium atrovirens G. Z. Zhao et T. Y. Zhang *sp. nov.* FIGURE 1

> *Coloniae in substrato naturali nigrae, granulosae, inconspicuae, constantes e sporodochiis arcte aggregates, sub lente sporodochia singula sparsa brunnea visibilia. Mycelium sparsum, pro maxima parte submersum. Conidiophora brevia, simplicia, non ramosa, erecta, recta vel flexuosa, pallide brunnea vel brunnea, 13-16µm longa, 1.5-3.5µm lata. Conidia singula in apice conidiophori oriunda, elliptica, ovoidea vel clavata, irregulariter muriformia, viridia vel atrovirentia, levia, 30-37 x 15-17µm; in parte basali obconica, denticulata, pallidiora vel subhyalina.*

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Habitat: In cortice emortuo Syzygii samarangensis (Bl.) Merr. & Perry, Nanning, Guangxi Provincia sinica, 9 XI 1999, leg. G. Z. Zhao, HSAUP992154 (=ZGZ990654), hic designatus holotypus. In ramis emortuis Artocarpi heterophylli Lam. Xiamen, Fujian Provincia sinica, 25 VII 2000, leg. X. Sun, HSAUPII$_0$5086 (=SX-20086).

Colonies on natural substrate black, granular, inconspicuous, consisting of groups of sporodochia. Under the stereo microscope individually scattered, superficial, brown sporodochia are visible. Mycelium scanty, mostly immersed. Conidiophores short, simple, unbranched, erect, straight or flexuous, pale brown to brown, 13-16 x 1.5-3.5μm. Conidia formed singly at the apex of each conidiophore, ellipsoidal, ovoid to clavate, irregularly muriform, green to dark green, with basal part paler than the upper part or subhyaline, smooth, 30-37 x 15-17μm, basal cell obconical, pale brown to subhyaline, truncate at the base.

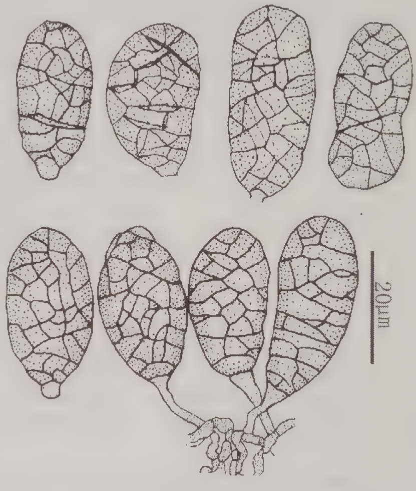

FIGURE 1 *Berkleasmium atrovirens*: Sporodochia, conidiophores and conidia from Holotype

Holotype: On dead bark of *Syzygium samarangense* (Bl.) Merr. & Perry, **Nanning**, **Guangxi Province**, 9 Nov 1999, Coll. G. Z. Zhao, *HSAUP992154 (=ZGZ990654)*. Other specimen examined on dead branch of *Artocarpus heterophyllus* Lam., **Xiamen**, **Fujian Province**, **CHINA**, July 25, 2000, Coll. X. Sun, *HSAUPII$_0$5086 (=SX-20086)*.

This fungus, in conidium morphology and size, is close to *Pithomyces sumiderensis* Hol.-Jech. (Holubová-Jechová & Mercado, 1986). The conidia of the two species are both clavate or obovoid. It is difficult to separate them by conidium characters. However, the sporulation patterns in the two genera are obviously different. Conidiophores or conidiogenous cells in *Pithomyces* are generally very short and erect on creeping hyphae, the conidia are liberated by rhexolytic secession. Fungi in *Berkleasmium* often form fundamentally sporodochial conidiomata and grow slowly in the substrates. In addition, conidium color is a striking character in distinguishing them from each other. Conidium color of the new taxon is dark green, while that of *Pithomyces sumiderensis* is brown or dark brown.

Berkleasmium taishanense G. Z. Zhao et T. Y. Zhang *sp. nov.* **FIGURE 2**

Sporodochia disseminata, punctiformia, atra, nitentia, saepe inconspicua. Mycelium immersum, ex hyphis pallide brunneis laevibus ramosis septatis 1-2μm latis compositum. Conidiophora semimacronematosa vel micronematosa, fasciculata, simplicia, sensim septata, erect, recta vel flexuosa, laevia, hyaline vel subhyalina, usque ad 10μm longa, 1.5-2μm lata, vesiculis inflatis 7μm crassis praedita. Cellulae conidiogenae monoblasticae in conidiophoris incorporatae, terminales, clavatae vel pyriformes, laeves. Conidia acrogena, solitaria, irregulariter muriformia, ellipsoidea, clavata, obovata vel pyriformia, brunnea vel atro-brunnea, levia, 22-35 x *15-18.75μm, aliquot conidia separata saepe cellulis conidiogenis persistentibus.*

Etym.: L., *taishanense* = referring to Taishan mountain area, the type locality.

Habitat: in ligno putrido rami emortui arborum indeterminatarum in Mounte Taishan, Shandong Provincia sinica, 10 VII 2001, leg. G. Z. Zhao, HSAUPII$_{01}$*0452 (=ZGZII*$_{01}$ *002), Holotypus.*

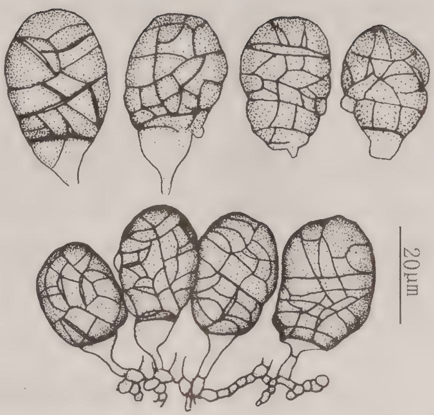

FIGURE 2 *Berkleasmium taishanense*: Sporodochia, conidiophores and conidia

Sporodochia scattered, punctiform, black, shining, often inconspicuous. Mycelium immersed in the substrate, composed of pale brown, smooth, septate, 1-2μm wide hyphae. Conidiophores semimacronematous or micronematous, fasciculate, simple, unbranched, inconspicuously septate, erect, straight or flexuous, smooth, hyaline to subhyaline, up to 10μm long (including the conidiogenous cell), 1.5-2μm wide, with bladder-like swelling 7μm wide. Conidiogenous cells monoblastic, integrated, terminal, clavate or pyriform, inflated, smooth. Conidia acrogenous, solitary, dry, ellipsoidal, clavate, obovate or pyriform, brown to dark brown, 22-35 x 15-18.75μm, when detached usually carrying away with them the upper part of the conidiophore.

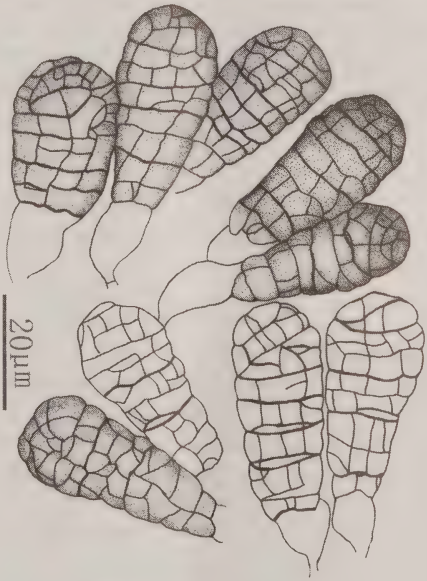

FIGURE 3 *Berkleasmium inflatum*: Conidiogenous cells and conidia

On rotten wood of dead branch of an undetermined tree. Mount Taishan, **SHANDONG PROVINCE, CHINA**, 10 July 2001, Coll. G. Z. Zhao, *HSAUP*$_{01}$*0452 (=ZGZII*$_{01}$*002)*, Holotype.

Berkleasmium taishanense resembles *B. atrovirens* and *B. inflatum* with respect to conidium morphology. However, it can be separated from *B. atrovirens* by conidium color and basal cell characters. The characteristic green to dark green colored conidia and the small unswollen conidial basal cell of *B. atro virens* provide the useful features in differentiating *B. atrovirens* from *B. taishanense*. Conidia of *B. inflatum* reach a size range of 30–47 x 18.5-21μm, and they are considerably larger than conidia of *B. taishanense*. The much more inflated cells of conidiophore in *B. inflatum* are also helpful in separating *B. inflatum* from *B. taishanense.*

Berkleasmium inflatum Hol.-Jech., 1987, Ceská Mykologie, 41(1):29-31. **FIGURE 3**

Conidiophores clavate to obpyriform, up to 30μm long (including the conidiogenous cells), apical cell inflated, 6-9.5μm wide. Conidia obovoid, dark brown in the apical part, pale brown in the basal cells, 30-47 x 18.5-21μm.

On dead rotten wood, **CHONGQING**, **CHINA**, Aug. 8 2000, Coll. G. Z. Zhao, *HSAUPII*$_0$*2745 (=ZGZII*$_0$*0445).*

This collection differs slightly from the original description (Holubová-Jechová, 1987). In the original description, the conidiophore had 1-3 bladder-like swellings, but in our collection only 1 bladder-like swelling was found. Other characters are consistent with the original description.

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Literature Cited

Holubová-Jechová V, Mercado Sierra A, 1986. Studies on hyphomycetes from Cuba IV. Dematiaceous hyphomycetes from the Pinar del Rio Province. Ceská Mykologie **40**(3): 142-164.

Holubová-Jechová V. 1987. Studies on hyphomycetes from Cuba V. Six new species of dematiaceous hyphomycetes from Havana province. Ceská Mykologie **41**(1): 29-31.

Moore RT. 1958. Deuteromycetes I: The *Sporidesmium* complex. Mycologia **50**: 681-692.

Moore RT. 1959. The genus *Berkleasmium.* Mycologia **51:**734-739.

Rao PR, D Rao. 1964. "*Berkleasmium*" Zobel from India. Mycopathologia **22**: 311-314.

中国砖格孢子丝孢菌研究 IV. 顶丛格孢属*

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摘 要:报道顶丛格孢属的两个新种，暗绿顶丛格孢*Berkleasmium atrovirens* G. Z. Zhao et T. Y. Zhang和泰山顶丛格孢*Berkleasmium taishanense* G. Z. Zhao et T. Y. Zhang，和一个中国新记录种，膨梗顶丛格孢*Berkleasmium inflatum* Hol.-Jech。研究标本保存在山东农业大学植物病理学标本室（HSAUP）。

关键词:新种，暗绿顶丛格孢，泰山顶丛格孢

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Glomus hyderabadensis, a new species: its taxonomy and phylogenetic comparison with related species

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Abstract—A novel *Glomus* species was isolated from rhizosphere soils supporting *Allamanda cathartica* from Hyderabad, India. The spores proliferate and bud out a daughter spore terminally which is connected to the mother spore by a small connective. Sequence analysis of D1D2 variable domain of 26S ribosomal RNA gene of this *Glomus* sp. shows that it is different from other known AM fungi. The morphological and molecular phylogenetic analyses support the creation of *Glomus hyderabadensis* sp. nov.

Key words—morphotaxonomy, molecular sequencing, phylogeny

Introduction

The genus *Glomus* Tulsane & Tulsane represents by far the largest genus within the Glomerales and is placed in the monogeneric family Glomeraceae (Schüßler et al. 2001). Based on rRNA SSU analysis and on the basis of natural relationship of AM fungi, a new fungal phylum Glomeromycota has been erected (Schüßler et al. 2001). Taxonomy and identification of glomalean fungi has traditionally relied on the morphology of their large multinucleate spores. Phylogenetic analysis based on ribosomal RNA gene sequences (Redecker et al. 2000, Schwarzott et al. 2001) indicate that the genus is non-monophyletic in nature.

During a survey of the rhizosphere soils of medicinal plants an interesting arbuscular mycorrhizal (AM) fungus belonging to genus *Glomus* was collected. The spores of this AM fungus are unique, as they proliferate / bud out a daughter spore terminally. The wall layers in the daughter spore are similar to the mother spore. This type of proliferation or bud out spore production is not reported in any of the existing AM fungi (Morton & Benney 1990; Schenck & Perez 1990; Manoharachary et al. 2002). Further the other spore characteristics do not match with any of the described species under genus *Glomus*. Sequence analysis of the D1/D2 variable domain of 26S ribosomal RNA gene shows that the sequence of this fungus is different from all the existing AM fungi reported in the literature, hence it is described here as a new taxon.

Materials and Methods

Collection of AM fungal spores

The AM fungal spores were isolated by wet sieving and decanting method (Gerdemann & Nicolson 1963) from the rhizosphere soil of *Allamanda cathartica* L. (Apocyanaceae).

DNA isolation

Twenty spores were washed thoroughly three times with sterile distilled water. DNA was isolated using GenElute™ Plant Genomic DNA kit, G2N10 (Sigma Chemical Company, St. Louis, USA). The fungal spores were mechanically disrupted in a 1.5 ml microfuge tube using disposable pistel (Sigma Chemical Company, St. Louis, USA). The lysis of spores and purification of DNA was performed as per manufacturer's instructions.

Amplification of ITS region and D1D2 region of 26S ribosomal RNA gene

The entire ITS and D1D2 variable domain of 26S rRNA was amplified with primers pITS1 (5'-TCC GTA GGT GAA CCT GCG G-3') (White et al. 1990) and pNL4 (5'-GGT CCG TGT TTC AAG ACG G-3') (Kurtzman & Robnett 1998). The primers were obtained from Integrated DNA Technologies, Inc., USA. Polymerase Chain Reactions were performed in a final reaction mixture (100μl) containing 50ng genomic DNA, 25pmols each of primers (pITS1 and pNL4R), 200 mM each of dATP, dTTP, dGTP and dCTP (Promega Corporation, USA); 2.5mM $MgCl_2$ and 2.0 units of Taq polymerase (Promega); and 10 μl of 10X reaction buffer (Promega). The amplification reactions were performed in a PTS 100 Mini Cycler (MJ Research, USA) with the following cycling parameters; initial denaturation for 5 minutes at 94°C, followed by 30 cycles of 30 seconds at 94°C, 30 seconds at 55°C and 1.0 min at 72°C, with a final extension for 10 minutes at 72°C and cooled at 4°C. The amplified products were separated on 1.2%

agarose (Sisco Research Laboratories, India) gel by electrophoresis and visualized by staining with ethidium bromide (0.5μg/ml). Gel photographs were taken using VDS Image Master (Pharmacia Biotech, USA).

Sequencing of D1D2 region

Direct sequencing of PCR-amplified ITS and D1/D2 domains was performed by using ABI Big Dye Terminator kit. The D1D2 variable domain of 26S ribosomal RNA was performed with 2 primers, pNL1 (5'-GCA TAT CAA TAA GCG GAG GAA AAG-3') and NL4. Sequencing reactions were purified by ethanol and sodium acetate precipitation, the pellet was washed twice with 70% ethanol, which considerably improved the removal of dye terminators from the reaction. Processing of the samples for loading on to ABI 310 model sequencer was performed as per manufacturer's instructions. The oligonucleotide primers used for sequencing were procured from Integrated DNA Technologies (IDT), USA.

Molecular phylogenetic analysis

The sequences were aligned using Clustal X program (Thompson et al. 1997) and manually corrected. Sequence similarity search was done using GenBank BLASTN search (Altschul et al. 1990), sequences of closely related taxa were retrieved and used for phylogenetic analysis. The GenBank accession numbers of the related species are given in the phylogenetic tree. For the Neighbour-Joining analysis (Saito & Nei 1987), the distances between the sequences were calculated using Kimura's two-parameter model (Kimura 1980). Sites where gaps existed in any of the sequences were excluded.

Nucleotide sequence accession number

The D1D2 domain sequence determined in this study has been deposited in GenBank database with the following number: AY211274

Results and Discussion

Glomus hyderabadensis Swarupa, Kunwar, Prasad et Manohar ***sp. nov.*** **Figs. 1-7**

> Sporocarpia ignota. Sporae singulae, globosae, subglobosae vel ellipsoidae, 97-136 μm diametro, melleus vel aurantius-brunneus; sporae tunica e stratis tribus in uno terma (terma A). Hypha sustinens singulus, infundibuliformis. Maturus sporae prolificus terminalis, procreans gemmiformis sporae filiales; sporae filia sessilis, singulae, globosae, vel sub-globosae vel ellipsoideus. Sporae filialis consociatus cum nater sporae ab apertus connectivum.
>
> [***Etymology***: Specific epithet derived from the place of collection (Hyderabad)].
>
> HOLOTYPUS HIC DESIGNATUS ex ralix solum *Allamanda cathartica,* Hyderabad, India. 30. 5. 2001, leg. Swarupa, Herb. No. HCIO 43,918.

Sporocarps unknown. Spores formed singly, globose, subglobose to ellipsoidal, 97-136 μm in diam, honey coloured to orange-brown; spore wall as three walls in a single group (group A). Composite spore wall 3.3-5.9 μm thick, adherent, outer wall smooth or roughened, dull yellow, 1.1-2.4 μm, in older spores walls perforated, with an aperture of 1-1.5 μm diam, middle wall single, non layered, rigid, unit, orange-brown, 1.1-2.7 μm, inner wall rigid, non layered, dull yellow, 1.1-2.1 μm. Subtending hypha single, slightly flared toward the point of attachment, 15-32 μm thick, 136-233 μm long, rarely branched, pore in the subtending hypha occluded by a thick straight septum. Mature spores proliferating terminally, producing bud-like daughter spore; daughter spore sessile, single, globose, subglobose, ellipsoidal, 18-48.4 μm in diam, honey coloured to orange-brown; composite daughter spore wall 3-5.6 μm thick, number of wall groups one (group A), adherent, three wall layers, outer wall smooth or roughened, dull yellow, 1-2.2 μm thick, middle wall single, non layered, rigid, unit, orange-brown, 1-2 μm thick, inner wall rigid, non layered, dull yellow, 1-1.8 μm thick. Daughter spore linked to mother spore by an open connective, 5.6-9.5x8.2-11 μm.

Glomus hyderabadensis is characterized by the production of sessile, single, daughter spores from the mother spore and perforations in the spore wall. The spore measurements and wall characteristics also differ from the known species of *Glomus* (Schenck & Perez 1990). These observations merit its description and erection as a new taxon of species rank.

Glomus pustulatum Koske, Friese, C. Walker & Dalpe produces numerous hyaline, circular to irregular blister like thickenings on the outermost spore wall (Koske et al. 1986). In the present fungus only one daughter spore is produced per mother spore and the colour and wall structure of the daughter spore is like the mother spore. In *G. etunicatum* W.N. Becker & Gerd. the outer wall is smooth or roughened from decomposition of outer wall and adherent debris but has two groups (A and B) of spore walls and the composite wall is thicker (4-13 μm) (Becker & Gerdemann 1977), whereas in the new taxon only one group (A) of spore wall is present and it is thinner (3.3-5.9 μm).

Perforations in the wall are reported in *G. geosporum* (T.H. Nicolson & Gerd.) C.Walker also, but these perforations are sometimes absent from mature specimens and the middle wall is laminated. The inner wall is membranous and forms a septum separating the spore contents from the lumen (Walker 1982). However, in the present fungus perforations are present in the mature spores, outer wall is dull yellow and is always intact even at maturity unlike in *G. geosporum* where it is

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Figs. 1-7. *Glomus hyderabadensis* Scale bar = 30 μm. 1. Mother spore with young terminal daughter spore (arrow). 2. Daughter spore detached from mother spore, subtending hypha flared at the point of attachment with the spore (arrow). 3. Ellipsoidal spore. 4. Subglobose spore. 5. Daughter spore connected with the mother spore with a connective (arrow), septum (arrow) at the point of attachment of subtending hypha with the spore. 6. Similar three layered wall in mother and daughter spore (arrows). 7. Perforations (arrows) in the spore wall.

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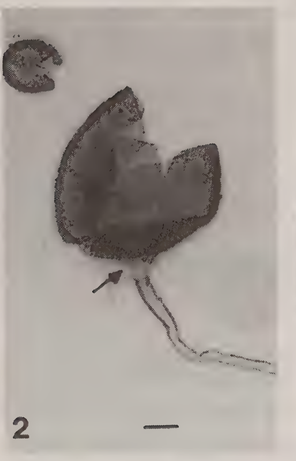
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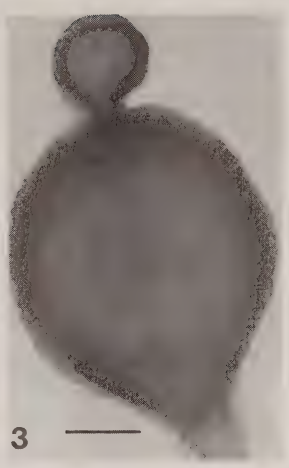
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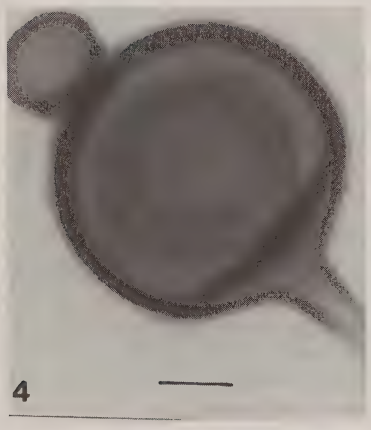
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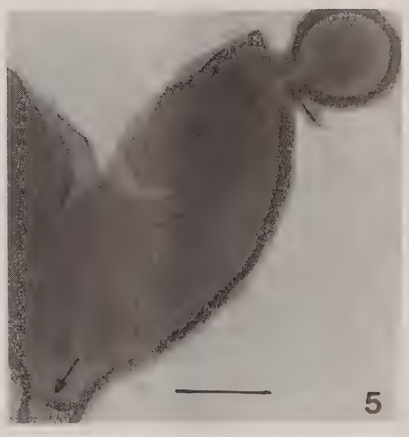
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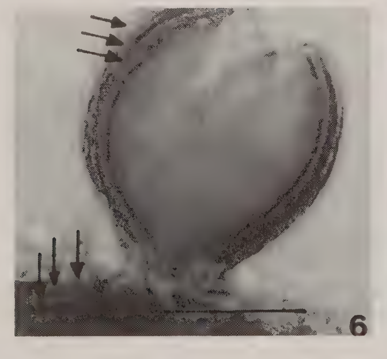
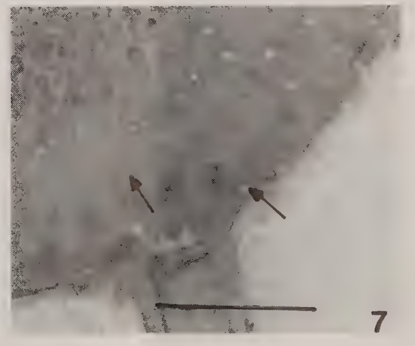

6


7

hyaline and sometimes absent from mature specimens. In *G. multisubstensum* Mukerji, Bhattacharjee & J.P. Tewari and *Gigaspora rosea* T.H. Nicolson & N.C. Schenck (= *Gi. candida* Bhattacharjee, Mukerji, J.P. Tewari & Skoropod) perforations are reported but they seem to be caused due to hyperparasitism. In. *G. multisubstensum* the perforations were seen in surface view while in sectional view transverse fissures were seen (Mukerji et al. 1983). In *Gi. rosea* the perforations in the spore wall appeared to be caused by the parasitic action of soil microorganisms since its inner surface showed numerous hypha like structures passing through the perforations (Bhattacharjee et al. 1982). The perforations were either dispersed or in groups and varied in size indicating that more than one type of parasite may have been involved, while in our study of *G. hyderabadensis* perforations were uniformly distributed and were mostly uniform in size.

In *G. globiferum* Koske & C. Walker the spores are formed singly or in pairs or triplets adhering to each other by common peridial hyphae, bearing numerous terminal or intercalary, globose or ovoid vesiculate swellings (Koske & Walker 1986). Wheras in *G. hyderabadensis* peridium is absent with single daughter spore attached to the mother spore.

Phylogenetic analysis

The ITS and D1/D2 region was amplified with primers ITS1 and NL4, the amplicon was about 1.2 kb. Attempts to sequence the ITS region with primers ITS1, ITS2, ITS3 and ITS4 were unsuccessful for unknown reasons. As an alternative, we have sequenced the D1/D2 domain of 26S rRNA gene. The 26S rRNA domain D1/D2 have been determined for all the known yeast taxa (Kurtzman & Robnett 1998; Fell et al. 2000) and are extensively used for describing new yeast species along with morphological and physiological characters. With few exceptions, the yeast taxa that differ by more than 1% variation in the D1/D2 domain are considered as separate species (Kurtzman & Robnett 1998; Fell et al. 2000). The D1/D2 sequence of PCR amplified ITS-D1D2 fragment was determined using primers NL1 and NL4. Both the strands of the PCR product were sequenced. The determined sequence is 510 bases in length.

GenBank search using BLAST (Altschul et al. 1990) resulted in retrieval of several algal sequences. However, these sequences showed 23.6 to 35.1% variation with *G. hyderabadensis* sequence and appear to be not closely related to *G. hyderabadensis*. The first 10 hits were as follows, GYNRGNP *Gymnodinium catenatum* Graham, AF409122 *Mallomonas asmundae* (Wujek and van der Veer) Nichols, AF409121 *Chrysolepidomonas dendrolepidota* Peters and Anderson, AF318261 *Dinophyceae* gen. sp. *antifer* Cons4, AF409125 *Vacuolaria virescens* Cienkowski, AF210742 *Vacuolaria virescens,* AF417673 *Nitzschia laevis* Hust., AF417670 *Nitzschia alba* (Kütz) W. Smith, AF210743 *Olisthodiscus luteus* Carter and OD28SRRNA *Ochromonas danica* Prings. *Glomus* sp. HCIO – 43,918 differs from the algal taxa by 23.6 to 35.1% variation. The sequence divergence among the algal taxa used in the analysis ranged from 15.5 to 34.3%, suggesting that they are highly divergent sequences. Our attempts to culture algae from the crushed spores of *Glomus* sp. HCIO-43,918 on different media did not yield any algal species.

As the morphotaxonomic features of the new fungus suggest that it may be a new *Glomus* species, we restricted our next BLAST search to Glomeromycota. The first hits in the BLAST search were *Archaeospora gerdemannii* (S.L. Rose, B.A. Daniels & Trappe) J.B. Morton & D. Redecker AJ510234, AJ271712 and AJ510233 followed by *Glomus occultum* C. Walker AJ271713. Phylogenetic position of *G. hyderabadensis* in relation to other AM fungi based on D1/D2 variable domain sequences is shown in Figure-8. Based on the sequence analysis of D1/D2 domain *Ar. gerdemannii* is the nearest relative of *Glomus* sp. HCIO – 43,918, but the

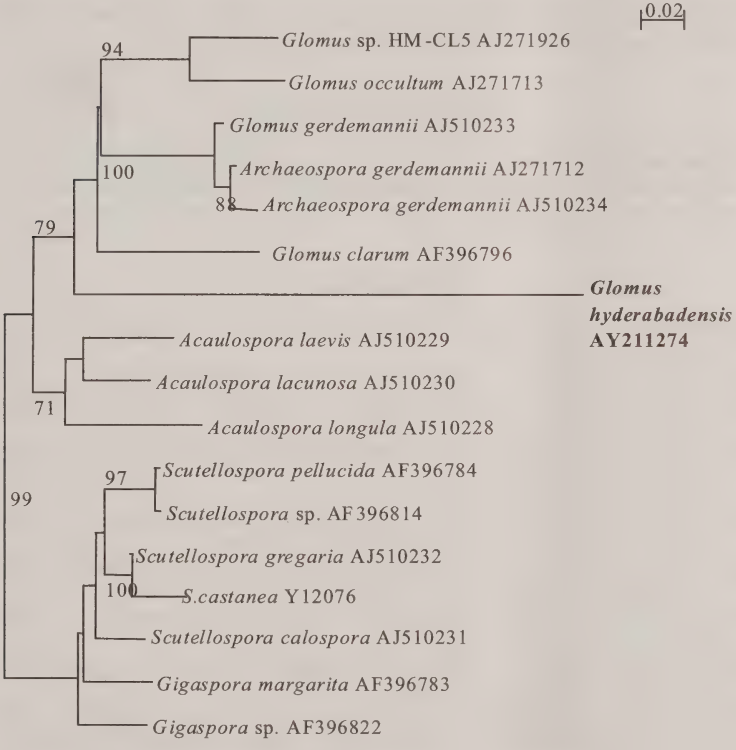

0.02
94
Glomus sp. HM-CL5 AJ271926
Glomus occultum AJ271713
Glomus gerdemannii AJ510233
100
Archaeospora gerdemannii AJ271712
88
Archaeospora gerdemannii AJ510234
79
Glomus clarum AF396796
Glomus hyderabadensis AY211274
Acaulospora laevis AJ510229
Acaulospora lacunosa AJ510230
71
Acaulospora longula AJ510228
97
Scutellospora pellucida AF396784
99
Scutellospora sp. AF396814
Scutellospora gregaria AJ510232
100
S.castanea Y12076
Scutellospora calospora AJ510231
Gigaspora margarita AF396783
Gigaspora sp. AF396822

Fig. 8. Phylogenetic tree depicting the relationship between *Glomus hyderabadensis* and other reference taxa. The tree was constructed based on D1/D2 variable domain of 26S rDNA using program N J Plot. Bootstrapping was done in 1000 replications. Values for frequencies less than 70% are not given.

new fungus differs from its nearest relative by more than 29.2% sequence variation. The sequence variation between two isolates of *Ar. gerdemannii* was 0.8%. Variation among the three *Acaulospora* sp. viz. *A. lacunosa* J.B. Morton, *A. longula* Spain & N.C. Schenck and *A. laevis* Gerd. & Trappe ranged from 9.3 to 9.8% indicating that they are distinct species.

Among the *Glomus* species, *Glomus* sp. strain HM-CL5 has more sequence imilarity to *Glomus* sp. HCIO – 43,918, however both of them differ from each other by 30.5% variation. *G. occultum* is the nearest relative of *Glomus* sp. strain HM-CL5 (6.8% variation). Interestingly *Glomus* sp. strain HM-CL5 differs from other *Glomus* species used in the sequence analysis by 16.1 to 22.2% variation. These results indicate that D1/D2 sequences are highly divergent among *Glomus* species.

These results together with the novel morphotaxonomic features of *Glomus* sp. HCIO – 43,918 support the description of a new taxon *G. hyderabadensis*.

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References

Altschul SF, Gish W, Miller W, Myers EW, Lipman DJ. 1990. Basic local alignment search tool. J. Mol. Biol. 215: 403-410.

Becker WN, Gerdemann JW. 1977. *Glomus etunicatum* sp. nov. Mycotaxon 6: 29-32.

Bhattacharjee M, Mukerji KG, Tewari JP, Skoropod WP. 1982. Structure and hyperparasitism of a new species of *Gigaspora*. Tr. Br.. Mycol. Soc. 70: 101-106.

Fell JW, Boekhout T, Fonseca A, Scorzetii G, Statzell-tallman A. 2000. Biodiversity and systematics of basidiomycetous yeasts as determined by large subunit rDNA D1/D2 domain sequence analysis. Int. Syst. Evol. Microbiol. 50: 1351-1371.

Gerdemann JW, Nicolson TH. 1963. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. Tr. Br. Mycol. Soc. 46: 235-244.

Kimura M. 1980. A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. J. Mol. Evol. 16: 111-120.

Koske RE, Walker C. 1986. *Glomus globiferum,* a new species of Endogonaceae with a hyphal peridium. Mycotaxon 26: 133-142.

Koske RE, Friese C, Walker C, Dalpe Y. 1986. *Glomus pustulatum* a new species in the Endogonaceae. Mycotaxon 26: 143-149.

Kurtzman CP, Robnett CJ. 1998. Identification and phylogeny of ascomycetous yeasts from anlaysis of nuclear large subunit (26S) ribosomal DNA partial sequences. Antonie Leeuwenhoek 73: 331-371.

Manoharachary C, Kunwar IK, Mukerji KG. 2002. Arbuscular Mycorrhizal Fungi - Identification, Taxonomic Criteria, Classification, Controversies and Terminology, pp. 249-272. in: Techniques in Mycorrhizal Studies (K G. Mukerji, C. Manoharachary, B. P. Chamola, eds.) Kluwer Academic Publ. Netherland.

Morton JB, Benney GL. 1990. Revised classification of arbuscular mycorrhizal fungi (Zygomycetes): A new order *Glomales*, two new suborders, *Glominae* and *Gigasporinae*, and two new families, *Acaulosporaceae* and *Gigasporaceae*, with an emendation of *Glomaceae*. Mycotaxon 37: 471-491.

Mukerji KG, Bhattacharjee M, Tewari JP. 1983. New species of vesicular- arbuscular mycorrhizal fungi. Tr. Br. Mycol. Soc. 81: 641-643.

Redecker D, Morton JB, Bruns TD. 2000. Ancestral Lineages of Arbuscular Mycorrhizal Fungi (Glomales). Mol. Phylogenetics Evol. 14: 276–284.

Saito N, Nei M. 1987. The neighbor-joining method: a new method for reconstructing phylogenetic trees. Mol. Biol. Evol. 4: 406-425.

Schenck NC, Perez Y. 1990. Manual for the Identification of VA Mycorrhizal Fungi, pp. 283. Synergistic Publ., Gainsville, Florida, USA.

Schüßler A, Schwarzott D, Walker C. 2001. A new fungal phylum, Glomeromycota: Phylogeny and evolution. Mycol. Res. 105: 1413-1421.

Schwarzott D, Walker C, Schüßler A. 2001. *Glomus*, the largest genus of the arbuscular mycorrhizal fungi *(Glomales)* is nonmonophyletic. Mol. Phylogenetics Evol. 21: 190–197.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The Clustal X windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. 24: 4876-4882.

Walker C. 1982. Species in the *Endogonaceae*: A new species (*Glomus occultum*) and a new combination (*Glomus geosporum*). Mycotaxon 15: 49-61.

White TJ, Burns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics, pp. 315-322. In: PCR protocols (M. A. Iunis, D.H. Geffand, J. J. Suinsky, T. J. White, eds.) San Diego, California, Acad. Press.

MYCOTAXON

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Changes and additions to the checklist of North American Lichens. - I

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Abstract–*Bactrospora macrospora* has been found to be synonymous with *Gyalecta lamprospora*, resulting in the new combination *Bactrospora lamprospora*. *Lecidea hebescens* is placed in synonymy with *Porpidia albocaerulescens*, and *Arthonia willeyi* is placed in synonymy with *A. diffusa*. The following taxa are lectotypified: *Arthonia diffusa*, *Arthonia willeyi*, *Gyalecta lamprospora*, *Lecanora pleiospora*, *Lecanora pleistospora*, *Lecanora thelococcoides*, and *Lecidea hebescens*.

1. *Arthonia diffusa* Nylander

Arthonia diffusa Nylander, Flora, 68(24): 448. 1885. TYPE: On bark, Illinois, USA. *Hall s.n.* (H-NYL 5046a!, lectotype [**selected here**]; PH!, isolectotype; H-NYL 5044!, H-NYL 5045!, H-NYL 5047! syntypes (see below).
Arthonia diffusa Nylander *nom. nud.*, Mem. Soc. Sci. Nat. Cherbourg, 5: 337. 1858.

Syn. nov. *Arthonia willeyi* Tuckerman *ex* Hedrick, Mycologia, 25(4): 311. 1933. TYPE: On trees near Athens, Illinois, USA. *Wolf s.n.* (PH!, lectotype [**selected here**])

Arthonia diffusa is a distinctive species, apparently endemic to eastern North America, that is easily recognized by its sessile usually pruinose ascomata, often constricted at the base; large, usually pruinose pycnidia; *Trentepohila* photobiont and 2-septate ascospores. The measurement of immature ascospores likely accounts for the size difference noted by Hedrick when establishing *A. willeyi*. Thus, Willey's (1890) recognition that the then-unpublished *A. willeyi* was identical with *A. diffusa* is confirmed.

As discussed by Lendemer & Hewitt (2002) there are five syntype specimens of *A. diffusa* in H-NYL, four of which include material from New England. It was two of these specimens collected by Edward Tuckerman that served as the basis for Nylander's invalid publication of the name in 1858. The description of 1885 however, includes three additional specimens; two collected by Henry Willey and one by Elihu

Hall in Illinois. The Hall collection is here selected as the lectotype because both pycnidia and apothecia are present on the specimen.

Though a holotype was clearly designated in the protologue of *A. willeyi*, the specimen could not be found at MICH (P. Rogers, pers. comm.). Thus, the isotype in PH is here selected as the lectotype. Further study of *Arthonia* will likely show that additional names should be placed in synonymy with *A. diffusa*.

2. *Bactrospora lamprospora* (Nylander) Lendemer *comb. nov.*

Gyalecta lamprospora Nylander, Flora, 68(16): 312-313. 1885. TYPE: On bark, near Philadelphia, Pennsylvania, USA. *Eckfeldt 45* (PH!, lectotype [**selected here**]; H-NYL 21968!, isolectotype).

Syn nov. *Bactrospora macrospora* R. C. Harris, Some Florida Lichens, 40. 1990. TYPE: On *Acer*, hardwood swamp, just E of Loften Creek on Fla. Hwy. A1A, 5.5 miles W of Amelia River, Nassau Co., USA. *Harris 21152* (NY!, holotype).
Melampylidium macrosporum (R. C. Harris) Henssen *in* Henssen & Thor *in* Hawksworth, DL (ed.): Ascomycete Systematics. Problems and Perspectives in the Nineties, p. 45.

The generic disposition of *Bactrospora macrospora* has been the subject of some controversy. However, Egea and Torrente (1995) consider *Melampylidium* Stirton a synonym of *Bactrospora* A. Massalongo. Harris (1995) also argued for retaining *B. macrospora* in *Bactrospora*. Refer to Harris (1990) or Egea and Torrente (1993) for a description of *B. macrospora*.

3. *Porpidia albocaerulescens* (Wulfen) Hertel & Knoph

Lichen albo-caerulescens Wulfen *in* Jacquin, Collect. Bot. 2: 184, tab. XV. fig. 1. 1788. TYPE: *Arnold Lich. Exs. 894* (M, neotype (selected by Hertel, 1977). (for synonymy see Hertel, 1984)

Syn. nov. *Lecidea hebescens* Nylander, Sert. Lich. Trop., 41. 1891. TYPE: On rock, Lookout Mountain, Tennessee, USA. *Calkins s.n.* (H-NYL 15497!, lectotype [**selected here**]; PH!, NY! probable isolectotypes).

Fink (1935) included *L. hebescens* as a synonym of *P. albocaerulescens*. Magnusson (1936) however, retained the species on the basis of the brown coloration of the thallus. Other then the brown coloration the type collection is typical *P. albocaerulescens*. See Gowan (1989) for a description of this species.

4. *Acarospora thelococcoides* (Nylander) Zahlbruckner

Lecanora thelococcoides Nylander, Set. Lich. Trop., 37. 1891. TYPE: On soil, southern California, USA. *Orcutt s.n.* (H-NYL 24962!, lectotype [**selected here**]). EPITYPE: On granite derived soil, open spaces in full sun among *Adenostoma fasciculatum* chaparral, Menifee Hills, Wildomar, Riverside Co., California, USA. *Knudsen 529* (hb. Lendemer!, epitype [**selected here**]; herb.

Knudsen, hb. Lendemer, ASU!, BG!, CANB!, CHR!, FH!, H!, MIN!, NDA!, NY!, OSU!, SBBG!, TNS!, UC!, isoepitypes).

Acarospora thelococcoides (Nylander) Zahlbruckner, Lich. Catalogus, 5: 98. 1928

Lecanora pleiospora Nylander *in* Hasse, Bull. Tor. Bot. Club, 24(9): 446. 1897. TYPE: On clay, San Gabriel Mountains, California, USA. *Hasse s.n.* (H-NYL 24865!, lectotype [**selected here**]; H-NYL 24868!, isolectotypes).

Acarospora pleiospora (Nylander *in* Hasse) Zahlbruckner, Beihefte Bot. Centralbl., 13: 163. 1902.

Lecanora pleistospora Nylander *in* Hasse, Bull. Tor. Bot. Club, 24(9): 446. 1897. TYPE: On clayey soil, Soldier's Home, Los Angeles Co., California, USA. *Hasse s.n.* (H-NYL 24866!, lectotype [**selected here**]; PH!, isolectotype).

Acarospora pleistospora (Nylander *in* Hasse) Zahlbruckner, Beihefte Bot. Centralbl., 13: 163. 1902.

The synonymy of *A. thelococcoides* presented here has already been proposed previously by Magnusson (1929). However, recent research (Knudsen, 2003) resulted in the discovery that Hasse (1897) confused *A. pleistospora*, with *A. obpallens*. The later descriptions by Hasse (1913) show that he corrected this confusion. The names *L. pleiospora* and *L. pleistospora* are not currently included in the North American checklist (Esslinger 1997). However, they should be included as synonyms of *A. thelococcoides* because specimens with these obsolete names remain un-annotated in many herbaria. It is important to note that the type material of *L. pleistospora* is in fact a mixture of *A. thelococcoides* (the lectotype) and *A. obpallens* (H-NYL 24867). The specimen representing *A. thelococcoides* is here selected as the lectotype because *L. pleistospora* and *L. obpallens* were simultaneously published and the best course of action seems to be to reduce *L. pleistospora* into synonymy with a name that clearly has priority. Also, all specimens (examined by Knudsen) later distributed by Plitt in *Lichenes Exsiccati ex Herb. Dr. H. E. Hasse Relicti* under the names *A. pleistospora* and *A. pleiospora* are *A. thelococcoides*. See Knudsen (2003) for a discussion of the differences between *A. obpallens* and *A. thelococcoides*. Because the type specimen of *A. thelococcoides* consists of only a few fertile areoles I have chosen to designate (and widely distribute) a recent collection as an epitype to aid future workers in the application of this name.

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Literature Cited

Egea JM, Torrente P. 1993. The lichen genus *Bactrospora*. The Lichenologist, 25(3): 211-255.

Egea JM, Torrente P. 1995. *Melampilidium metabolum* belongs in *Bactrospora*. Mycotaxon, 53: 57-61.

Esslinger TL. 1997. A cumulative checklist for the lichen-forming, lichenicolous and allied fungi of the continental United States and Canada. North Dakota State University: http://www.ndsu.nodak.edu/instruct/esslinge/chcklst/chcklst7.htm (First Posted 1 December 1997, Most Recent Update July 17, 2002), Fargo, North Dakota.

Fink B. 1935. The Lichen Flora of the United States. Completed for Publication by Joyce Hedrick. University of Michigan Press, Ann Arbor. xii + 426 pp.

Gowan SP. 1989. The lichen genus *Porpidia* (Porpidiaceae) in North America. The Bryologist, 92(1): 25-59.

Harris RC. 1990. Some Florida Lichens. New York, USA. 109pp.

Harris RC. 1995. More Florida Lichens. New York, USA. 169pp.

Hasse HE. 1897. New species of lichens from Southern California as determined by Dr. Nylander and the late Dr. Stizenberger. Bulletin of the Torrey Botanical Club, 24(9): 445-449.

Hasse HE. 1913. The lichen flora of Southern California. Contributions to the United States National Museum, 17(1): 1-132.

Henssen A, Thor G. 1994. Developmental morphology of the "Zwischengruppe" between Ascohymeniales and Ascoloculares. *In:* Hawksworth, DL (ed.): Ascomycete Systematics. Problems and Perspectives in the Nineties. NATO Advanced Science Institutes Series, Plenum Press, New York, pp. 43-56.

Hertel H. 1977. Gesteinsbewohnende Arten der Sammelgattung *Lecidea* (Lichenes) aus Zentral-, Ost- und Südasien. Khumbu Himal, Ergebnisse des Forschungsunternehmens Nepal Himalaya, 6: 145-378.

Hertel H. 1977. 1984. Über saxicole, lecideoide Flechten der Subantarktis. Beiheft zur Nova Hedwigia, 79: 399-499.

Knudsen K. 2003. Type Specimens: Investigations and Observations. Bulletin of the Californian Lichen Society, 10(2): 36-38.

Lendemer JC, Hewitt DA. 2002. A Catalogue of the Type Specimens of Lichens in the Herbarium of The Academy Of Natural Sciences of Philadelphia. Proceedings of the Academy of Natural Sciences of Philadelphia, 152: 173-204.

Magnusson AH. 1929. A monograph of the genus *Acarospora*. Kongl. Svenska Vetenskaps-Akademiens Handlingar, Stockholm 7: 1-400.

Magnusson AH. 1936. On saxicolous species of the genus *Lecidea* proper to North America. Meddel. Göteborgs Bot. Trädgard 10: 1-53.

Nylander W. 1885. Arthoniae novae Americae borealis. Flora, 68(16): 311-313.

Nylander W. 1885b. Arthoniae novae Americae borealis. Flora, 68(24): 447-449.

Willey H. 1885. *Gyalecta lamprospora*. Bulletin of the Torrey Botanical Club, 12(6): 61-62.

Willey H. 1890. A Synopsis of the Genus *Arthonia*. New Bedford, Massachusetts, 62pp.

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Synopsis and systematic reconsideration of *Karlingiomyces* (Chytridiomycota)

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Abstract—The genus *Karlingiomyces* is reviewed and the validity of endo-operculation as a character is questioned in comparison to exo-operculation. *Karlingiomyces* has been considered an operculate member of the *Rhizophlyctis/Karlingia* complex, an assemblage of saprotrophic, interbiotic, mostly monocentric Chytridiomycota. Members of this complex have similar thallus morphology, including often more than one discharge pore and several main rhizoidal axes per sporangium. However, a definite exo-operculum delimits *Karlingiomyces* species from other taxa of the complex. *Karlingiomyces* contains five species, of which three are chitinophilic and two are cellulosic. One of the cellulosic species, *Karlingiomyces exooperculatus,* represents a new combination. A key to species of *Karlingiomyces*, descriptions, illustrations, information on types, and discussions of taxa are provided. Based on probable endo-operculation and on what may be assessed of the zoospore, three other species of *Karlingiomyces* and one variety are excluded from the genus. Recent morphological and molecular data have cast doubt on the continued inclusion of *Karlingiomyces* in the *Rhizophlyctis/Karlingia* complex.

Key words—chytrid, monocentric, nomenclature, operculum, polycentric, zoospore

Introduction

Rhizophlyctoid fungi were conceived as eucarpic, monocentric, interbiotic Chytridiomycota (Rhizidiaceae, *sensu* Sparrow 1943, 1960) possessing subspherical to asymmetric sporangia, commonly with more than one discharge papilla and with several main rhiziodal axes. Characteristically each rhizoidal axis arises from a different point on the sporangium. This rhizophlyctoid assemblage at first included two groups: (1) the inoperculate members of *Rhizophlyctis* that Fischer (1892) established and Minden (1911) emended (cf. Sparrow 1943) and (2) endo-operculate (wall-like material contained within the discharge papillae) species described as *Karlingia* (Johanson 1944). Sparrow (1960) later erected *Karlingiomyces* for exo-operculate (operculum apical on the papilla) *Rhizophlyctis*-like chytrids. However, the exo-operculate condition prompted Sparrow to place *Karlingiomyces* in the Chytridiaceae (*sensu* Sparrow 1960) rather than in the Rhizidiaceae. Regardless of supposed family and order assignments, Dogma (1973) considered that the "rhizophlyctoid alliance" contained *Rhizophlyctis, Karlingia* and *Karlingiomyces*. Barr (1980) later emended *Karlingia* Johanson based on zoospore ultrastructure.

Questions of validity of primary taxonomic characters for members of this "alliance" have generated disagreement. Distinguishing features for classification within this alliance include the development of the discharge papillae, the nature of operculation, and the mode of zoospore discharge. Based on Haskins' (1948, 1950) and Haskins & Weston's (1950) studies of lower Chytridiales, Sparrow (1960) considered endo-operculation an unreliable character. Sparrow believed that virtually any chytrid, especially *Rhizophlyctis*-like chytrids, could produce a so-called endo-operculum, even if typically inoperculate or exo-operculate. Sparrow (1960) thus placed the "endo-operculate genus" *Karlingia* Johanson (1944) in synonymy of *Rhizophlyctis*. On the other hand, Sparrow (1960) considered exo-operculation of major systematic importance and placed exo-operculate species of *Karlingia* in his genus *Karlingiomyces*. Karling (1966) disagreed with Sparrow and re-established *Karlingia* for rhizophlyctoid chytrids that were endo- or exo-operculate (Karling 1977a, 1977b). Karling (1966) regarded *Karlingiomyces* as a synonym of *Karlingia*. Dogma (1973, 1974) recognized all three "rhizophlyctoid" genera: *Rhizophlyctis* (inoperculate), *Karlingia* (endo-operculate), and *Karlingiomyces* (exo-operculate). In an apparent change of mind, Sparrow (1973) also recognized all three genera. Blackwell & Powell (1999) noted that species of *Rhizophlyctis* could be either inoperculate or endo-operculate, obviating the need to separate the genus *Karlingia*. They showed that *Karlingia* was based on *Rhizophlyctis rosea,* the type for the genus, and concluded that *Karlingia* should be rejected on nomenclatural grounds regardless of further morphological considerations. In the "rhizophlyctoid alliance" (Dogma 1973), only the generic names *Rhizophlyctis* (applicable, *sensu lato*, to inoperculate and/or endo-operculate taxa) and *Karlingiomyces* (applicable to exo-operculate taxa) are available to formal nomenclature (Blackwell & Powell 1999). This does not, however, answer the question of how many genera of "rhizophlyctoid chytrids" exist or the extent to which these are related. Recent evidence indicates that *Karlingiomyces* is perhaps more closely related to certain polycentric forms than to *Rhizophlyctis* (James et al. 2000), a concept we expand in the Discussion.

Inasmuch as *Karlingiomyces* Sparrow (1960) is a valid genus, it remains to be determined: which taxa should be included in it (cf. Longcore 1996), which taxa should be transferred to other genera such as *Rhizophlyctis*, and which taxa presently assigned elsewhere such as *Karlingia* should be admitted to *Karlingiomyces?* Such considerations require refinement of the understanding and limits of characters that define the genus. Is exo-operculation, for example, a truly meaningful character in classification; is endo-operculation inconsistent or inappropriate for generic characterization; and, are there other characters correlated with or additional to operculation that may be employed to strengthen the generic concept? Clearly we need to determine whether there is substantive reason to continue with the concept of the "rhizophlyctoid alliance" (sensu Dogma 1973) or if this "alliance" is merely an umbrella for morphologically more or less similar (*Rhizophlyctis*-like) taxa, some related and others not. Generic relationships and general systematic questions relating to *Karlingiomyces* are also considered in the Discussion. Our taxonomic synopsis of *Karlingiomyces* follows Sparrow (1960) with explanations of synonymy and other taxonomic matters outlined as necessary. Our treatment differs from Sparrow's in precisely which taxa are accepted in the genus. Included taxa are presented first, followed by taxa that we consider too questionable for inclusion. Descriptions are adapted from Karling (1949, 1977b) and Sparrow (1960), but other sources were also consulted (e.g., Willoughby 1957; Dogma 1973, 1974).

Taxonomic Descriptions

KARLINGIOMYCES Sparrow
Aquatic Phycomycetes, 2nd ed., p. 559, 1960

Vegetative: Thallus usually interbiotic; rhizoidal tips penetrating the substrate. **Reproductive:** Usually monocentric, eucarpic; sporangium developed from the encysted zoospore or more rarely from the germ tube of the zoospore, forming one to several discharge papillae, each surmounted by a distinct exo-operculum; endo-opercula sometimes formed within the papilla. **Rhizoidal system:** Typically of several main rhizoidal axes, arising at different points on the sporangium, the rhizoidal axes branching. **Zoospore discharge:** Zoospores released free or as a relatively compact group in a vesicle or a gelatinous matrix, at first motionless but soon becoming active and swarming. **Zoospore microscopic:** Posteriorly uniflagellate, spherical; typically with a single large, hyaline, refractive lipid globule located laterally, toward the posterior of the cell. **Zoospore ultrastructure:** Unknown. **Resting spore:** Formed either asexually or sexually, the wall often somewhat thickened, the wall surface relatively smooth to rugose or significantly ornamented with pegs or spines; resting spore borne like sporangium on the thallus, upon germination functioning as a prosporangium. **Ecology and Distribution:** Apparently widespread in soil or water; saprophytic on chitinous, keratinous and cellulosic debris; genus known from eastern UNITED STATES, ENGLAND, AUSTRALIA, NEW ZEALAND, MAYLASIA, and INDIA; also AFRICA ("Liberia", indet. to species, cf. Dogma 1973).

Latin description of genus provided by Sparrow (1960), p. 559.

Type of genus: Sparrow (1960) designated *Karlingiomyces asterocystis* as the "species typica" of *Karlingiomyces*. This "type species" of *Karlingiomyces* was based on *Karlingia asterocysta*, described by Karling (*Mycologia* 41: p. 509, 1949). Since, according to Article 10.1 of the *International Code of Botanical Nomenclature* (ICBN, 2000), "the type of a name of a genus…is the type of a name of a species", see this further typification under *Karlingiomyces asterocystis* (Karling) Sparrow.

Key to Species of *Karlingiomyces*

1.Chitinophilic or keratinophilic; rhizoids with or without constrictions; sporangial exit papillae one to four, low and dome-shaped or conical and more conspicuous; resting spore wall "spiny" (i.e., with peg-like projections), roughened or smooth in appearance.

2.Resting spore wall with distinct pegs or spine-like processes; rhizoids relatively thin to relatively thick-walled, but not showing appreciable constrictions; exo-operculum up to 18 μm in diameter, the rim flush on exit papilla orifice (or sporangial surface); zoospores usually less than 5 μm in diameter.

3.Resting spore ornamentations usually straight, blunt, peg-like, relatively sparse; released zoospores at first swarming in an evanescent vesicle outside the sporangium; zoospore flagellum 24-26µm in length; exit papillae often barely rising above sporangial surface; sporangia intercalary 1. *K. asterocystis*

3.Resting spore ornamentations often spiny, acute, hamate, numerous; released zoospores not contained in a vesicle, but may be temporarily immersed in extruded granular matrix material; zoospore flagellum 10-13 µm long; exit papillae usually more elevated; sporangia intercalary or stalked 2. *K. curvispinosus*

2.Resting spore wall smooth to rugose or verrucose; rhizoids thick-walled, distinctly constricted at intervals ("catenulate" appearance); exo-operculum up to 30 µm in diameter, appearing to "sit" on a raised, cushion-like area; zoospores usually more than 5 µm in diameter 3. *K. dubius*

1.Inhabiting cellulosic debris; rhizoids showing constrictions; sporangial exit papilla one or two, often becoming elongated and tube-like; resting spores smooth-walled or absent.

4.Operculum uniform in thickness (relatively thin); sporangium developing by enlargement of encysted zoospore; zoospores sometimes of two distinct sizes in a single sporangium; main rhizoid walls somewhat thickened, rhizoidal inclusions not readily evident; resting spores apparently lacking 4. *K. marylandicus*

4.Operculum distinctly thickened, especially toward the apex; sporangium developing from encysted zoospore or from a swelling of the zoospore germ tube; zoospores more uniform in size (not of two distinct size classes); rhizoidal axes relatively thin-walled, distinct globules and/or "inclusions" evident within; smooth-walled resting spores often produced 5. *K. exooperculatus*

Accepted species of *Karlingiomyces*

1. ***Karlingiomyces asterocystis*** (Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 560, 1960. **FIGURES 1-5**

Karlingia asterocysta Karling, Mycologia 41: 509, Figs. 9-19, 1949.

Vegetative: Thallus epibiotic on chitinous substrates. **Reproductive:** Sporangium hyaline, smooth-walled, spherical, oval, pyriform, oblong, fusiform, elongate or irregular, diameter 12-110 µm (usually toward the larger end of the range). **Rhizoidal system:** Extensive, branching, each of the main axes up to 18 µm in diameter. **Zoospore discharge:** Zoospore discharge papillae 1 to 4, low, often barely rising above the sporangial surface (more distinct, or relatively elevated, as much as 11 µm high on small sporangia), 8-14 µm in diameter; with a conspicuous hyaline area beneath, extending up to 16 µm into the sporangium; exo-operculum, convex though shallow, hyaline, diameter up to 14 µm; zoospores discharged *en masse* through opening left by expressed operculum, swarming briefly in an evanescent vesicle, then dispersing. **Zoospore microscopic:** Zoospore spherical, hyaline, 4.2-4.6 µm in diameter, with a single, relative large (0.7-1.2 µm) hyaline refractive lipid globule; flagellum 24-26 µm long. **Resting spore:** Subspherical, oval, oblong, angular or irregular, 12-30 µm in diameter, the contents hyaline; spore wall becoming dark greenish-brown, becoming more or less covered with blunt to somewhat pointed, straight or slightly curved (at the tip) peg-like "spines"; these pegs 4-8 µm in height, 2-4 µm broad at base, smooth or rarely verrucose, 22-60 per spore; pegs becoming dark greenish-brown (as the spore wall); resting spore germination not observed, though resting spores are sometimes found in greater numbers than sporangia. **Ecology and Distribution:** Saprophytic on chitinous material, such as insect exuviae; readily baited on shrimp exoskeleton (Murray & Lovett 1966); isolated from soil and water; US, Maryland (cf. Karling 1949, Sparrow 1960), Louisiana (cf. Murray & Lovett 1966); NEW ZEALAND (Karling 1967).

Type: No type specimen, as can be determined, was specifically designated or deposited, either by Karling or Sparrow. In accordance with Articles 8 and 9 of the *International Code of Botanical Nomeclature* (ICBN 2000), an illustration may be utilized as the type. Hence, Karling's illustration (Figs. 9-19) of (the basionym) *Karlingia asterocysta* Karling (Mycologia 41: p. 507, 1949) is accepted as the holotype of *Karlingiomyces asterocystis* (Karling) Sparrow (1960). These figures are also the type of the genus name *Karlingiomyces* (cf. Article 10, *ICBN* 2000). Original material of *Karlingia asterocysta* was isolated from soil and water, Charles County, Maryland.

Discussion: Karling (1967) attempted to return this species to *Karlingia* and used the epithet spelling "*asterocystis*" (applied to *Karlingiomyces* by Sparrow, 1960); if used as a final name element (e.g., "astero-cystis"), "-cystis" is permissible in either case (Stearn 1983). Regardless, the shallow but definite exo-opercula (Fig. 1)—no endo-opercula being evident in this case—support placement of this species in *Karlingiomyces*.

2. ***Karlingiomyces curvispinosus*** (Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 560, 1960. **FIGURES 6-9**
Karlingia curvispinosa Karling, Mycologia 41:511, Figs. 20-35, 1949

Vegetative: Thallus epibiotic on chitinous substrates, the substrate sometimes becoming discolored. **Reproductive:** Sporangium quite variable, sessile or occasionally stalked, subspherical, oval, pyriform, obclavate, oblong, or elongate, sometimes apiculate, 8-160 μm diameter, more or less hyaline, relatively thin- and smooth-walled, occasionally with in-growths (plugs) of wall material. **Rhizoidal system:** Much branched; usually developed from several main axes (formed at different points on the sporangium), these relatively coarse in appearance, up to 16 μm in diameter. **Zoospore discharge:** Zoospore discharge papillae 1 to 3, prominent to relatively obscure, conical or low and dome-shaped; exo-operculum 6-18 μm broad, somewhat convex, thin or slightly thickened, hyaline, ephemeral after dehiscence; zoospores not contained in a vesicle upon release from sporangium, but may be temporarily immersed in a granular matrix. **Zoospore microscopic:** Zoospores hyaline, spherical, 3.8-4.2 μm in diameter, with one prominent, hyaline refractive globule 0.6-0.8 μm broad; flagellum 10-13μm long. **Resting spore:** Spherical, oval, or slightly angular to somewhat irregular, 6-21 μm in diameter, contents granular, sometimes developing a small vacuole; young resting spore often surrounded by a hyaline zone of amorphous material; pegs or spines appearing to gradually develop in this hyaline layer; pegs or spines eventually becoming numerous, covering the resting spore surface, curved (somewhat hook-like) and pointed; resting spore more rarely merely echinulate, verrucose or smooth; color of resting spore eventually greenish- or dark-amber or brownish; resting spore, functioning as a prosporangium in germination. **Ecology and Distribution:** Soil or water; saprophytic on chitin or keratin substrates; often rapid and prolific in growth (readily cultured); resting spores sometimes imparting a distinctive greenish-amber or darkened coloration to the substrate; US, Maryland (cf. Karling 1949; Sparrow 1960), Maine (collections by J. E. Longcore, JEL 93 and JEL 223, are probably this species; however, resting spores, critical to determination, were not observed); NEW ZEALAND (Karling 1967).

Type: Karling's illustration (Figs. 20-35; Mycologia 41: p. 507 and 512, 1949) of *Karlingia curvispinosa* is accepted as the type of *Karlingiomyces curvispinosus* (Karling) Sparrow (1960). Original material isolated from soil and water in a ravine near the Monocacy River at Frederick, Maryland.

Discussion: Karling (1967) noted that New Zealand specimens of *K. curvispinosus* were identical with those from the United States, except for the "lack of a…clear zone" surrounding the developing resting spore—perhaps a "culture" or "artifact"-based observation.

3. ***Karlingiomyces dubius*** *(*Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 561, 1960. **FIGURES 10-14**
Karlingia dubia Karling, Mycologia 41:513, Figs. 36-51, 1949.

Vegetative: Thallus epibiotic on chitinous substrates. **Reproductive:** Sporangium subspherical, oval, pyriform or oblong, variable in diameter (15-240 μm), hyaline, smooth-walled. **Rhizoidal system:** Extensive, copiously branched; the several main rhizoidal axes each attaining a diameter of 12 to 16 μm, usually thick-walled, with a number of regular or irregular constrictions which may in places appear to virtually occlude the rhizoidal lumen (pseudo-catenulate). **Zoospore discharge:** Zoospore discharge papillae 1 to 4, low to relatively prominent, 12-34 μm in diameter, subtended by a more or less hemispherical hyaline zone that may extend as much as 16 μm into the sporangium; exo-operculum convex but shallow, 10-30 μm in diameter, relatively uniform in thickness, usually dehiscing prior to zoospore discharge and remaining for a time "perched" on hyaline material of the exit papilla (which appears as a "cushion"); zoospores eventually expressing the operculum, emerging together in a gelatinous "matrix" of material, but soon dispersing.

Zoospore microscopic: Zoospores spherical, hyaline, 6-6.5 μm in diameter, with a single, basal, relatively large (2-2.3 μm) hyaline globule apparent; flagellum long (32-35μm), but at first (upon zoospore discharge) obscure and coiled around body of zoospore, then uncoiling for motility and dispersal. **Resting spore:** Spherical, oval, elongate or somewhat angular, 8-20 μm in diameter, with relatively coarse, granular contents; resting spore wall smooth to rugose or verrucose, becoming dark brown; resting spores formed as result of sexual process (Willoughby 1957), remnants of the two fused gametangial bodies sometimes remaining evident externally on the resting spore (Dogma 1974); resting spore functioning as a prosporangium in germination (Dogma 1974). Ecology and Distribution: Soil and water; saprophytic on chitinous residue; readily baited, e.g., on shrimp exoskeleton; US, Maryland (cf. Karling 1949, Sparrow 1960); ENGLAND (Willoughby 1957, 1964); AUSTRALIA, State of Victoria (Willoughby 1965), New South Wales (recent observation P.M. Letcher); NEW ZEALAND (Karling 1967); MALAYSIA, Singapore (Dogma 1974).

Type: Karling's illustration (Figs. 36-51; Mycologia 41: p. 512, 1949) of *Karlingia dubia* is accepted as the type of *Karlingiomyces dubius* (Karling) Sparrow (1960). Original material isolated from Calvert County, Maryland.

Discussion: Some disagreement has occurred over taxonomic placement of *Karlingiomyces dubius*. Willoughby (1957) recognized Karling's (1949) *Karlingia dubia*, but confirmed the unique ("raised") exo-operculum (Willoughby's Figs. 3C,E). However, Sparrow (1960) transferred this species to his new genus, *Karlingiomyces*, on the basis of definitive exo-operculation. Although Sparrow selected *K. asterocystis* as the type of *Karlingiomyces*, it was only *K. dubius* that he elected to illustrate. Karling (1967) sought to return "*K. dubia*", among several taxa, to *Karlingia*. Dogma (1973), in a delimiting viewpoint of genera (based on differences in operculation), recognized all three genera of the "rhizophlyctoid assemblage" (*Rhizophlyctis*, *Karlingia* and *Karlingiomyces*). Dogma (1974) accepted *K. dubius* as exo-operculate, and as belonging to *Karlingiomyces*. We concur with Sparrow's and Dogma's placement of this species in *Karlingiomyces*.

4. *Karlingiomyces marylandicus* (Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 562, 1960. Spelling of the epithet given as "*marilandicus*" by Sparrow (1960).

FIGURES 15-17

Karlingia marylandica Karling, Mycologia 41:518, Figs. 70-78, 1949.

Vegetative: Extramatrical on cellulose substrates. **Reproductive:** Sporangium spherical, oval, pyriform, oblong to somewhat elongate or irregular, 20-85 μm in diameter, the wall smooth and often somewhat thickened (1.8-2.6 μm thick). **Rhizoidal system:** Rhizoid axes usually emerging from several different points on the sporangium (occasionally monorhizoidal, cf. Karling 1966), relatively coarse in appearance, up to 12 μm broad, irregularly constricted, the walls somewhat thickened, ultimately extensively branched. **Zoospore discharge:** Zoospore discharge papillae 1 or 2, varying from nearly sessile to elongate and tube-like (the "tube" straight, irregular or contorted), 10-15 μm broad, 10-205 μm long; exo-operculum up to 17 μm in diameter, convex, thin or uniformly thickened; endo-opercula sometimes also observed; zoospores emerging temporarily as a globular mass in a slimy matrix. **Zoospore microscopic:** Zoospores hyaline, spherical, either 5.5-6 μm or 2-3.5 μm (apparently of two sizes in the same sporangium), with a single, relatively large, hyaline refractive globule (0.8-2.8 μm broad). **Resting spore:** Not observed. **Ecology and Distribution:** Soil and water. Saprophytic on natural cellulose materials, i.e. various "vegetable debris", cellophane or bleached corn leaves; US, Maryland (cf., Karling 1949; Sparrow 1960); INDIA, Kerala State and Madras State (Karling 1966); NEW ZEALAND (Karling 1967).

Type: Karling's illustration (Figs. 70-78; Mycologia 41: p. 516, 1949) of *Karlingia marylandica* is accepted as the type of *Karlingiomyces marylandicus* (Karling) Sparrow (1960). Original material isolated from a farm near Frederick, Maryland.

Discussion: Karling (1966, 1967) did not accept Sparrow's (1960) placement of this species in *Karlingiomyces*, and continued to recognize it under *Karlingia*. Karling (1966) first accepted Sparrow's altered spelling "marilandica", then (1967) changed it back to the original "marylandica". According to the ICBN (2000), Article 60.4, the letter "y", foreign to classical Latin, is permissible in Latin scientific names. Since an original spelling (if not demonstrably incorrect) is to be retained (Article 60.1), there is no cogent reason to alter Karling's (1949) spelling, except for a termination appropriate to the generic name *Karlingiomyces,* viz. "*marylandicus*".

Dogma (1973) limited *Karlingiomyces* to only three species: *K. asterocystis*, *K. curvispinosus*, and *K. dubius*. Dogma suggested that *Karlingia marylandica* (=*Karlingiomyces marylandicus*) was among certain *Karlingia* species that, while appearing to be exo-operculate, were actually to be considered as endo-operculate—the operculum being interpreted as slightly sunken in the apex of the discharge papilla or exit tube, as revealed by a slight "collar-like" remnant of the papillar wall remaining above the operculum. However, Karling's (1949) original description and illustration and Sparrow's re-description (1960) of *Karlingiomyces marylandicus* indicate that this species is exo-operculate, although endo-opercula may also form, even in the same exit papilla (Karling 1949) surmounted by an exo-operculum (Fig. 16). Karling (1966) reconfirmed the predominantly exo-operculate character of this taxon.

It is difficult to know whether the lack of resting spores in *K. marylandicus* is real or merely apparent. A species such as *Karlingia rosea* (=*Rhizophlyctis rosea*), though known to occasionally produce resting spores, often does not exhibit these. Sparrow (1973) related this dearth of resting spores to the capacity of ordinary sporangia of *K. rosea* to form dormant, resistant structures, serving a similar perennating function to resting spores. Only further collecting and culture will demonstrate whether a comparable situation pertains to *Karlingiomyces marylandicus.*

5. *Karlingiomyces exooperculatus* (Karling) Blackwell, Letcher & Powell, *comb. nov.* **FIGURES 18-22**
Basionym: *Karlingia exooperculata* Karling, Nova Hedwigia 28:209, Figs. 1-16, 1977b.

Vegetative: Thallus generally extramatrical on celluose debris, eucarpic, monocentric,or occasionally polycentric. **Reproductive:** Sporangia developing from the encysted zoospore or from a swelling in germ tube of zoospore, spherical, subspherical, pyriform, ovoid, obpyriform or even reniform, sometimes irregular and somewhat elongate, highly variable in size (15-252 μm in diameter), hyaline, smooth-walled, the wall somewhat thickened (1.8-2.7 μm thick). **Rhizoidal system:** Rhizoidal axes up to 12 μm in diameter, relatively thin-walled, sometimes containing hyaline and other globules or inclusions, arising at several points on periphery of sporangium, or in some cases from the base of the sporangium, eventually much branched, extending considerable distances (up to 960 μm). **Zoospore discharge:** Zoospore discharge papillae 1 or 2, low in relief to long and tube-like, straight,curved or somewhat contorted, 6-240 μm long, 3-10 μm broad; exo-operculum conspicuous, 6-12 μm broad, usually rather strongly convex, often differentially thickened toward the apex; nature of zoospore discharge not reported. **Zoospore microscopic:** Zoospores spherical, 6-7 μm; a large hyaline refractive globule apparent, 3.5-4.2 μm in diameter; flagellum long (48-55 μm). **Resting spore:** Spherical, ovoid, oblong, or somewhat elongate, 10-28 μm in diameter, usually containing a large hyaline refractive globule; wall smooth, golden-brown, thickened (up to 4 μm), functioning as a prosporangium in germination. **Ecology and Distribution:** Saprophytic on cellulosic substrates, e.g., may be isolated on cellophane from watered soil cultures; US, Florida (Orlando), cf. Karling (1977b).

Type: Karling's illustration with analysis (Figs. 1-16; Nova Hedwigia 28: pp. 224-225, 1977b) of *Karlingia exoperculata* (the basionym, cf. Article 33.3, ICBN, 2000) may be accepted as the holotype of the new combination, *Karlingiomyces exoperculatus*. This illustration was in fact referred to by Karling as the "iconotypus". Original material of this taxon was isolated from a water culture of soil collected near Orlando, Florida.

Discussion: When Karling (1977b) described *Karlingia exooperculata* (the description we follow above) he made a point to distinguish *K. exooperculata*, from certain other "hyaline" species of *Karlingia* (e.g., *K. hyalina*), by its conspicuous external operculum. Because of the obvious exo-operculation, and the seemingly correlated feature of a spherical zoospore—containing a single, rather large, refractive globule—we believe that *K. exooperculata* is more properly placed in *Karlingiomyces*, than in *Karlingia*. As regards orthography, Longcore (1996), consistent with the citation in *Index of Fungi* (Vol. 4, p. 476), hyphenated the epithet (under *Karlingia*) as *exo-operculata*. However, Karling (1977b) employed the species epithet without a hyphen (viz. *exooperculata*); and, since non-hyphenation is generally preferable in scientific epithets (ICBN 2000, Article 60.9), we use the name without the hyphen. The termination (gender) of the epithet is, however, changed herein to *–us* (i.e., *exooperculatus*), appropriate to the genus name *Karlingiomyces*.

Excluded Taxa

1. *Karlingiomyces granulatus* (Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 563, 1960.
Karlingia granulata Karling, Mycologia 39: 57, Figs. 1-22, 1947.

Karling (1947) described this Brazilian species as *Karlingia* in a paper dealing with "new species with sunken opercula". Yet, Karling considered "the occurrence of exo- and endoopercula" a distinguishing character. Sparrow (1960) transferred *Karlingia granulata* to *Karlingiomyces*, presumably based on the nature of the operculum—which, though "delicate", could be considered "apical *or* submerged in the discharge papilla tube," a direct translation from Karling's (1947) Latin description. The exact position of the operculum is thus equivocal. From Karling's original figures (e.g., Figs. 9, 11), one might infer the origin as an endo-operculum, possibly near the summit of an exit papilla. Willoughby (1965), however, reported a single isolate of *Karlingiomyces granulatus* from Australia as exo-operculate. Subsequently, Dogma (1974) made a detailed study of the position of the operculum in a Colombian isolate of *K. granulata*. Dogma determined that this isolate (and presumably the species) possessed a type 2A endo-operculation (Dogma 1973, Sparrow 1973, Fig. 25) that superficially resembles exo-operculation. When zoospore discharge occurs, the operculum, initially possibly located near the apex of the discharge papilla, is pushed out by the zoospores (released in mass), much as an exo-operculum would be. However, the development of the operculum is technically that of an endo-operculum. Dogma (1974) noted that small collar-like flaps (papillar wall remnants external to the operculum) can be seen to persist—evidence that the source of the delicate operculum is endopapillar. Dogma (1974) accepted *Karlingia granulata* Karling, placing *Karlingiomyces granulatus* (Karling) Sparrow in synonymy.

Zoospores of *Karlingia granulata* do not appear comparable to those of the other species in *Karlingiomyces*. Zoospores of the *Karlingiomyces* species accepted are spherical and have one obvious, rather large, hyaline refractive lipid granule, usually at a rather specific position lateral or posterior in the cell. Although there has been no ultrastructural study of *Karlingiomyces* zoospores, based on light microscopy, which permits only a tentative conclusion, this type of zoospore seems consistent with what Barr (1980) called the "chytridialean" type. In contrast, the zoospore of *K. granulata*, though more or less spherical, contains a number of small refractive granules, none dominant in size or position. Sparrow (1960) emphasized the feature of numerous, coequal refractive granules in his key to alleged species of *Karlingiomyces*, as distinguishing *K. granulatus* and one other supposed species of *Karlingiomyces* (discussed below). It is possible that these two species were "distinct" within *Karlingiomyces* because of their misplacement in the genus. Thus, the zoospore of *K. granulatus* may be more consistent with types of zoospores other than chytridealean (Barr 1980, 1990, 2001; Barr & Désaulniers 1986). For the present, the only taxonomic place for *K. granulata* to reside is in the genus *Rhizophlyctis*.

2. *Karlingiomyces lobatus* (Karling) Sparrow, Aquatic Phycomycetes, 2nd ed., p. 563, 1960.
Karlingia lobata Karling, Mycologia 41: 515, Figs. 52-69, 1949.

This is an interesting taxon, often with wrinkled (older) sporangia and usually deeply lobed resting spores. However, the same points apply to *K. lobatus* as to *K. granulatus* in terms of taxonomic disposition. Known first from Maryland as *Karlingia lobata* (Karling 1949), Konno (1972) recognized it in Japan as *Karlingiomyces lobatus*. Dogma (1973), however, considered *K. lobata*, as well as *K. granulata*, to be strictly endo-operculate, in disagreement with Sparrow's (1960) conclusion of possession of both exo- and endo-opercula. As stated by Dogma (1973) the "exo-operculation is only apparent, not real". A careful study of Karling's (1949) original figures (e.g., Figs. 53, 56) suggests that Dogma's interpretation is correct,and hence this species should not be recognized in *Karlingiomyces*.

Zoospores of *K. lobata* have a number of small, variable (but more or less equal), refractive granules, indicative of a zoospore type more similar to *K. granulata* than to species included in *Karlingiomyces*. Karling (1949) noted that swimming zoospores of *K. lobata* were spherical, but that when coming to rest, "creep about", exhibiting a more elongate form with amoeboid properties. If demonstrated to be amoeboid while still in the swimming phase, this (along with the numerous, small lipid globules) would suggest the possibility of a spizellomycetalean type of zoospore (Barr 1980, 1990, 2001). As in the case of *K. granulata*, the placement of *K. lobata* would (temporarily at least) be in *Rhizophlyctis*.

Additionally, Karling (1984, *Nova Hedwigia* 40: 332) described a small-zoospored variety from Colombia, *K. lobata* var. *microspora*, bearing some resemblance to *K. granulata* (cf. Karling 1947). Regardless of its correct taxonomic placement, the zoospores (with multiple minute granules), and the exclusively endo-operculate (as stated by Karling) nature of the sporangial discharge "lid", would mitigate against including this "variety", as well as the above two species, in *Karlingiomyces*.

3. *Karlingiomyces laevis* Konno, Sci. Rept. Tokyo Kyoiku Daigaku, B, 14: 256, Plate 8 (Figs. E-H), 1972.

The presence (uniformly, as indicated by Konno) of only a single exit papilla on the sporangium of *K. laevis* does not necessilarily exclude this Japanese species from *Karlingiomyces*, although it does cast doubt on such a placement (cf. Sparrow 1960, 1973). However, *K. laevis* is described (in the figure legend), and illustrated, by Konno as (strictly) endo-operculate—and this would in fact exclude it from the exo-operculate genus *Karlingiomyces*. Konno (1972) provided a Latin diagnosis of *Karlingiomyces laevis*, disconnected from the English description (p. 256), and without reference to it, 12 pages following (p. 268). Konno (1972) described the zoospore of *K. laevis* as spherical, with a single large refractive globule. Thus, one cannot assume that all "rhizophlyctoid taxa" excluded from *Karlingiomyces* possess zoospores with multiple small globules (as in *K. granulatus* and *K. lobatus*).

In the same publication, Konno (1972) described a chytrid he commonly found in Japan, *Rhizophlyctis willoughbyi*. This species morphologically resembles *Karlingiomyces*, but the exact nature of the operculation is difficult to discern from Konno's description and illustrations. One or rarely two exit papillae are present on sporangia of *R. willoughbyi*. Regardless of its exact placement, mention here of this species, and of *K. laevis* above, addresses the issue that the number of "rhizophlyctoid" taxa (interbiotic, multiple rhizoidal axes) is probably underestimated and/or that these taxa are poorly understood (especially those bearing only a single exit papilla). More collecting, sampling, culture and descriptive work would be useful in obtaining a better appreciation of the diversity of *Rhizophlyctis*-like organisms.

Discussion

Acceptance of *Karlingiomyces* and its species depends on what is meant by "operculation" and its importance as a character in the taxonomy of Chytridiomycota. Sparrow (1933) stated that "the operculum impresses one as a morphological structure of some significance" and used it (1942, 1943) as the primary character separating groups of families in his Order Chytridiales. In emphasizing the systematic importance of operculation, Sparrow (1960) intended exo-operculation (i.e., delimiting his "operculate series" of chytrids from those that were "inoperculate"). Based partly on the work of Haskins & Weston (1950), Sparrow (1960) considered endo-operculation to be taxonomically unstable, "generically invalid" (Sparrow 1958), and possibly found in any chytrid with discharge papillae—although "rhizophlyctoid" chytrids seem prone to exhibit this feature (Sparrow 1960). Haskins

(1950) noted the erratic occurrence of endo-operculation, confusing the distinction made among certain chytrid genera (e.g., *Diplophlyctis* and *Nephrochytrium*).

Whiffen (1944) rejected operculation as a major character in chytridiomycete taxonomy. Instead she considered developmental pattern as a primary character, such as whether the encysted zoospore body or the germ tube gave rise to the sporangium or prosporangium. In *Karlingiomyces* sporangial development is directly from the zoospore; although, in *K. exooperculatus*, the sporangium may also arise from the germ tube. Powell & Koch (1977) showed a similar dual thallus developmental sequence, also within a single species, *Entophlyctis variabilis* (= *Powellomyces variabilis*, Longcore et al. 1995), casting doubt on the broader taxonomic significance of such a developmental character. Whiffen (1944), however, also emphasized other characters, i.e., whether a chytrid was holocarpic or eucarpic, and whether the thallus was monocentric or polycentric. Sparrow (1943, 1960) accorded importance to both of these latter characters. Barr (1980) felt that nuclear migration (whether the nucleus migrates into a germ tube or remains in the zoospore cyst) was a significant feature, supportive of Whiffen's developmental emphasis. But, Barr found a certain taxonomic consistency also in operculation. Barr's Chytridiales (defined by zoospore type) contained both operculate and inoperculate forms; yet, all operculate forms were found to belong to this order, not to the Spizellomycetales. Thus, Barr's findings support in part Sparrow's emphasis on operculation, as well as Whiffen's emphasis on development.

Karling (1937) also considered operculation to be systematically significant in chytrid taxonomy (e.g., *Endochytrium*), but eventually (1966, 1977) adopted a broad, less critically demanding, position—that operculation (exo- or endo-) was important, regardless of its exact nature. Karling recognized *Karlingia* Johanson as embracing both endo-and exo-operculate forms, seeing no need to recognize *Karlingiomyces* Sparrow as a separate "exo-operculate" genus. Dogma (1973) attempted to resolve this issue by recognizing an inoperculate category (e.g., certain *Rhizophlyctis* species), two categories of endo-operculate organisms (*e.g.*, various *Karlingia* species), and an exo-operculate category (*Karlingiomyces*), within the rhizophlyctoid assemblage of chytrids (Figs. 23-26). However, the taxonomic significance of an endo-operculum is suspect. Chambers & Willoughby (1964) indicated that in *Rhizophlyctis* (*Karlingia*) *rosea* endo-opercula sealed off the bases of open exit tubes. Correspondingly, Powell (1976) showed, in an ultrastructural study of *Entophlyctis*, that the endo-operculum is formed as a kind of wound response, after the opening of the exit papilla and release of the apical discharge plug—in other words, it is environmentally induced. Similarly, in *Rhizophlyctis rosea*, Powell (1994) demonstrated that the "endo-operculum" is a late addition of wall material covering exposed protoplast inside the papilla. These observations are consistent with statements by Sparrow (1960), Haskins (1948, 1950), and Haskins & Weston (1950). Endo-operculation is probably at least partly artifactual. Exo-operculation appears to have the sounder morphological and genetic basis. Hence, there is (to the reverse of Karling's opinion) a substantial reason for recognizing the exo-operculate genus *Karlingiomyces*, and distinguishing it from *Rhizophlyctis* (which is variously inoperculate or "endo-operculate"), but not for recognizing *Karlingia* (which is allegedly "endo-operculate", and nomenclaturally defunct in any case, cf. Blackwell

& Powell 1999). Our decision to include species in *Karlingiomyces* (*K. asterocystis, K. curvispinosus, K. dubius, K. marylandicus, K. exooperculatus*) hinges on the fact that a distinct exo-operculum has been demonstrated in each case.

Salkin (1970) noted that a similar exo-operculate genus, *Allochytridium,* resembled *Karlingiomyces* in sporangial morphology and in the often constricted, catenulate, rhizoids. Salkin suggested distinguishing *Allochytridium* from *Karlingiomyces* by a difference in the range of number of discharge papillae and by specific aspects of sporangial development. Sparrow (1973), in apparent agreement, separated the two genera by the key character of "sporangium with one discharge papilla" (*Allochytridium*), and "more than one" (*Karlingiomyces*). However, Salkin's (1970) original statement was that *Karlingiomyces* possessed "one or more discharge papillae", and *Allochytridium* "usually one discharge papilla". It is clear, however, that additional distinctions exist. The sporangium of *Karlingiomyces* typically develops by expansion of the zoospore cyst (in *K. exoperculatus* also by expansion of the germ tube); whereas in *Allochytridium* the sporangium consistently develops from the germ tube and, most significantly, eventually fuses with the zoospore cyst (Salkin 1970, Sparrow 1973, Karling 1977a). Whereas Powell & Koch (1977) pointed out that similar (not necessarily identical) thallus variations could occur within chytrid taxa, we nonetheless believe (as did Karling 1977a) that *Allochytridium* is distinct from other "rhizophlyctoid" genera (including *Karlingiomyces*) when total characters are considered. An additional potential distinguishing character in *Allochytridium* is that although several rhizoid groups arise at different points on the sporangium, as in *Karlingiomyces*, the initial grouping arises "from the endobiotic tip of the germ tube" (Salkin 1970, Karling 1977).

Although our decision to include species of "rhizophlyctoid morphology" in *Karlingiomyces* is based on the presence of an exo-operculum, one should not ignore zoospore type. Barr (1980) determined that two fundamentally different types of zoospores were represented in the former Chytridiales (cf. Sparrow 1960): (1) those characteristic of the Spizellomycetales (Barr 1980), and (2) those characteristic of the taxonomically narrowed Chytridiales (*sensu* Barr 1980). Barr (1990, 2001) extended his coverage to all groups of Chytridiomycota, and included additional zoospore types characteristic of orders such as Blastocladiales and Monoblepharidales. Barr's (1980) distinction of fungal zoospore types (spizellomycetalean and chytridialean), and Barr & Désaulniers' (1986) work on zoospore subtypes within the *Rhizophlyctis/Karlingia* complex, are especially pertinent to our study. Although distinctions of these zoospore types are mainly ultrastructural, certain critical features are, fortunately, also often discernible with the light microscope (Barr 1980). The morphology and structure of the zoospore, as visible with the light microscope, of all *Karlingiomyces* species accepted in our study are of an apparently chytridialean type, or are perhaps referable to subtype "D" of Barr & Désaulniers (1986). In either case, they are spherical and have a single large refractive lipid globule positioned posteriorly or laterally in the cell. Zoospores of certain alleged *Karlingiomyces* species that we do not include in the genus (*K. granulatus*, *K. lobatus*) appear to have multiple small lipid globules and other features, such as shape or movement, not consistent with included species. Our primary reason for excluding these taxa was, however, not the zoospore, but that they are apparently endo-operculate rather than exo-operculate. Although our decision for inclusion is based on exo-operculation, a certain zoospore type (chytridialean, a tentative conclusion based light microscopic features) appears to be consistent with included (exo-operculate) species. The zoospores of all alleged species of *Karlingiomyces* should be investigated with TEM. We note Barr's (2001) caveat that distinctive zoospore types occur within the order Chytridiales. As James *et al.* (2000) indicated, chytrids with chytridialean zoospores (*sensu lato*) may eventually be placed in several different, even disparate, clades of Chytridiomycota. Certainty of relationship cannot be asserted on the basis of general zoospore type, especially at the light microscopic level.

Most chytrid systematists (e.g., Sparrow 1943, 1960, Whiffen 1944, Karling 1977a, Barr 1980) have considered the monocentric/polycentric distinction as significant at one taxonomic level or another. The majority of chytrids (including *Karlingiomyces*) are monocentric. Polycentric chytrids have been classified in one (Whiffen 1944) or

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Figs. 1-5. *Karlingiomyces asterocystis*. 1. Multi-operculate zoosporangium. 2. Early stage of vesicle discharge from sporangium with exo-operculum visible at the right of the discharge plug. 3. Mass of zoospores emerging into an exogenous discharge vesicle. 4. Mature resting spore covered with peg-like processes. 5. Spherical zoospore with single lipid globule.

Figs. 6-9. *Karlingiomyces curvispinosus*. 6. Zoosporangium with multiple rhizoidal axes, typical of interbiotic growth habit. 7. Zoosporangia (zoospores evident within), showing exit papillae; sporangium on right is stalked. 8. Release of zoospores into a densely granular matrix. 9. Mature resting spore, and variously shaped pegs or spines that ornament the wall.

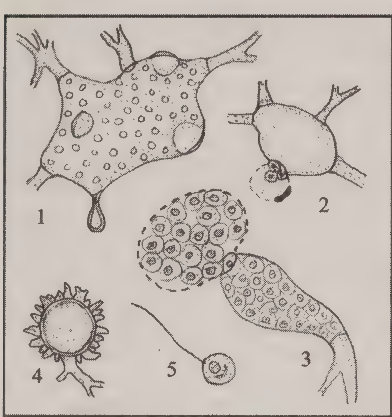
Figs. 10-14. *Karlingiomyces dubius* 10. Zoosporangium bearing thick-walled, irregularly constricted rhizoidal axes. 11. Exit orifice and detached (but still "perched"), relatively broad, exo-operculum. 12. Initial zoospore discharge with exo-operculum pushed to the right of the discharge plug matrix. 13. Mature resting spores; on the one on the left, remnants of both putative gametangial bodies evident, the wall verrucose; the one on right exhibits the more typical smooth wall. 14. Characteristic, relatively large zoospores; conspicuous hyaline globule evident toward posterior of the cell.

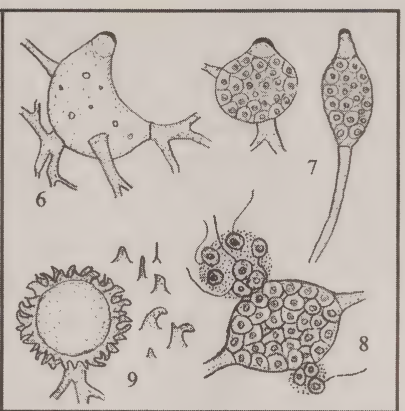
Figs. 15-17. *Karlingiomyces marylandicus*. 15. Zoosporangium with thickened wall and irregularly constricted rhizoids. 16. Zoosporangia with elongate exit tubes, each with a shallowly convex, exo-operculum (detached); endo-operculum evident near apex in sporangial exit tube on right. 17. Two sizes of zoospores, each with a single hyaline globule.

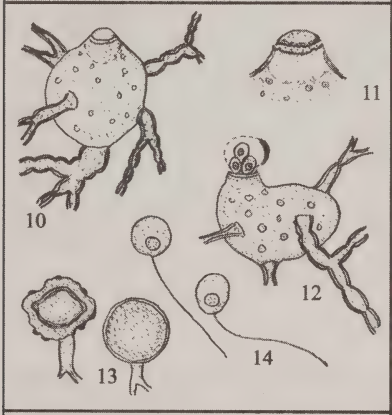
Figs. 18-22. *Karlingiomyces exooperculatus*. 18. Germinated zoospore with enlargement evident in germ tube. 19. Stage in sporangium development. 20. Pyriform sporangium (right); sporangium with elongate exit tube (left); note thickened exo-operculum. 21. Smooth, thick-walled resting spore containing a single, large refractive globule. 22. Zoospores, each with a single, posteriorly oriented, refractive globule.

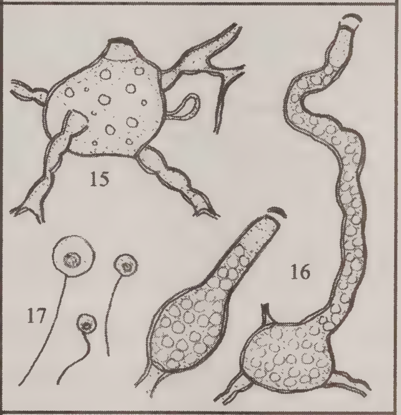
Figs. 23-26. Developmental stages of discharge papillae for a variety of sporangial discharge forms. 23. Zoospore discharge from an inoperculate papilla. 24. Dehiscence and discharge from an exo-operculate papilla. 25. Endo-operculate discharge papilla from which zoospores are released *en masse* and passively. 26. Endo-operculate discharge in which zoospores are explosively released.

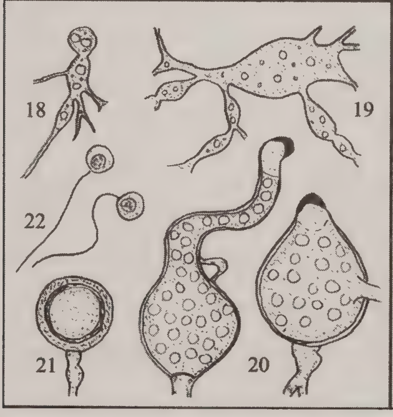
*Drawings adapted, with permission of the journal, from Karling (1949, 1977b) and Dogma (1973).

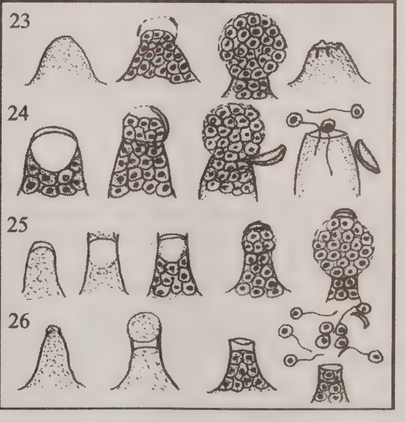












two (Sparrow 1960) families of their own. However, the systematic distinction between monocentric and polycentric chytrids may blur with additional knowledge. Blackwell et al. (2002) noted that a presumed monocentric form such as *Chytridium* (*Diplochytridium*) *lagenaria* may develop endobiotically a polycentric aspect. A monocentric chytrid, in which the nucleus migrates from the zoospore cyst or sporangium (Barr 1980) into the rhizoidal system, is capable of developing additional reproductive bodies and thus becoming to an extent polycentric. Powell & Koch (1977) showed, in *Entophlyctis variabilis* (=*Powellomyces variabilis*), that zoospore cysts with migrating and non-migrating nuclei may occur in the same taxon. The polycentric condition probably arose, independently, a number of times in the Chytridiomycota, the monocentric condition being the putative initial state in each instance. An example of a progression from monocentric to polycentric thalli may be seen in *Catenophlyctis* (Karling 1965). Karling (1977a, 1977b) noted that in certain species of *Karlingia* (=*Rhizophlyctis*) the thallus, usually monocentric, may occasionally become polycentric. *Karlingiomyces* may also prove interesting in this regard, in that at least one species (*K. exooperculatus*) may likewise develop in a polycentric fashion (Karling 1977b). *Karlingiomyces* is especially intriguing because, based on molecular data (James *et al*. 2000), it did not cluster (if the isolate utilized in the study was truly *Karlingiomyces*) with forms of superficially similar morphology, such as *Rhizophlyctis rosea*, but with the "*Lacustromyces* clade". The *Lacustromyces* clade contains polycentric forms such as *Polychytrium*, and the relatively recently described polycentric genus *Lacustromyces* (Longcore 1993). The generally polycentric "*Nowakowskiella* clade" (James *et al*. 2000), also including *Allochytridium*, might also be explored for possible relationships with *Karlingiomyces*. Further developmental, ultrastructural and molecular studies should clarify the relationships of *Karlingiomyces* and its overall systematic position.

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Literature Cited

Barr DJS. 1980. An outline for the reclassification of the Chytridiales, and for a new order, the Spizellomycetales. Can. J. Bot. 58:2380-2394.

Barr DJS. 1990. Phylum Chytridiomycota. Pages 454-466 *in* Handbook of Protoctista (L. Margulis et al., eds.) Jones and Bartlett, Boston.

Barr DJS. 2001. Chytridiomycota. Pages 93-112 *in* The Mycota, VIIA (D.J. McLaughlin et al., eds.) Springer, Berlin and Heidelberg.

Barr DJS, Désaulniers NL. 1986. Four zoospore subtypes in the *Rhizophlyctis-Karlingia* complex (Chytridiomycetes). Can. J. Bot. 64:561-572.

Blackwell WH, Letcher PM, Powell MJ. 2002. The question of the separation of *Diplochytridium* from *Chytridium* sensu lato. Mycotaxon 83:183-190.

Blackwell WH, Powell MJ. 1999. The nomenclatural propriety of *Rhizophlyctis rosea.* Mycotaxon 70:213-217.

Chambers T, Willoughby LG. 1964. The fine structure of *Rhizophlyctis rosea,* a soil phycomycete. J. Roy. Micr. Soc. 83:355-364.

Dogma IJ Jr. 1973. Developmental and taxonomic studies on rhizophlyctoid fungi, Chytridiales. I. Dehiscence mechanisms and generic concepts. Nova Hedwigia 24:393-411.

Dogma IJ Jr. 1974. Developmental and taxonomic studies on rhizophlyctoid fungi, Chytridiales. IV. *Karlingia granulata*, *Karlingia spinosa* and *Karlingiomyces dubius*. Nova Hedwigia 25:91-105.

Fischer A. 1892. Archimycetes (Chytridinae). Pages 3-160 *in* Kryptogamen-flora von Deustschland, Oesterreich und der Schweiz. 1(4) Phycomycetes. (L. Rabenhorst, ed.) Leipzig.

Haskins RH. 1948. Studies in the lower Chytridiales. Thesis, Harvard University.

Haskins RH. 1950. Studies in the lower Chytridiales. II. Endo-operculation and sexuality in the genus *Diplophlyctis*. Mycologia 42:772-778.

Haskins RH, Weston WH Jr. 1950. Studies in the lower Chytridiales. I. Factors affecting pigmentation, growth, and metabolism of a strain of *Karlingia* (*Rhizophlyctis*) *rosea*. Amer. J. Bot. 37:739-750.

ICBN. 2000. International Code of Botanical Nomenclature. Adopted by the Sixteenth International Botanical Congress, St. Louis, Missouri. Koeltz Scientific Books, Konigstein, Germany. (W. Greuter et al., eds.).

Index Of Fungi. 1940-present. Commonwealth Mycological Institute, Kew, Surrey. Vol. 4, part 15, page 476, 1978, contains listing of "*Karlingia exo-operculata*".

James TY, Porter D, Leander CA, Vilgalys R, Longcore JE. 2000. Molecular phylogenetics of the Chytridiomycota supports the utility of ultrastructural data in chytrid systematics. Can.J. Bot. 78:336-350.

Johanson AE. 1944. An endo-operculate chytridiaceous fungus: *Karlingia rosea*, gen. nov. Amer. J. Bot. 31:397-404.

Karling JS. 1937. The structure, development, identity, and relationship of *Endochytrium*. Amer. J. Bot. 24:352-364.

Karling JS. 1947. Brazilian chytrids. X. New species with sunken opercula. Mycologia 39:56-70.

Karling JS. 1949. New monocentric eucarpic operculate chytrids from Maryland. Mycologia 41:505-522.

Karling JS. 1965. *Catenophlyctis*, a new genus of the Catenariaceae. Amer. J. Bot. 52:133-138.

Karling JS. 1966. The chytrids of India with a supplement of other zoosporic fungi. Sydowia (Annales Mycologici, Ser. 2), Beiheft 6, 125 pp.

Karling JS. 1967. Some zoosporic fungi of New Zealand. VII. Additional monocentric operculate species. Sydowia 20:119-128.

Karling JS. 1977a. Chytridiomycetarum Iconographia. Lubrecht & Cramer, Monticello, New York.

Karling JS. 1977b. Some zoosporic fungi of Florida. Nova Hedwigia 28:209-229.

Karling JS. 1984. Zoosporic soil fungi of La Guajira, Colombia. Nova Hedwigia 40:329-340.

Konno K. 1972. Studies of Japanese lower aquatic Phycomycetes. Sci. Rept. Tokyo Kyoiku Daigaku, Ser. B, 14:227-292.

Longcore JE. 1993. Morphology and zoospore ultrastructure of *Lacustromyces* gen et sp. nov. (Chytridiales). Can J. Bot. 71:414-425.

Longcore JE. 1996. Chytridiomycete taxonomy since 1960. Mycotaxon 60:149-174.

Longcore JE, Barr DJS, Désaulniers N. 1995. *Powellomyces*, a new genus in the Spizellomycetales. Can J. Bot. 73:1385-1390.

Minden M von. 1911. Chytridiineae, Ancylistineae, Monoblepharidineae, Saprolegniinea. Kryptogamenflora, Mark Brandenburn 5(3):353-496.

Murray CL, Lovett JS. 1966. Nutritional requirements of the chytrid *Karlingia asterocysta*, an obligate chitinophile. Amer. J. Bot. 53:469-476.

Powell MJ. 1976. Development of the discharge apparatus in the fungus *Entophlyctis*. Arch. Microbiol. 111:59-71.

Powell MJ. 1994. Production and modifications of extracellular structures during development of Chytridiomycetes. Protoplasma 181:123-141.

Powell MJ, Koch WJ. 1977. Morphological variations in a new species of *Entophlyctis*. I. The species concept. Can. J. Bot. 55:1668-1685.

Salkin IF. 1970. *Allochytridium expandens*, gen. et sp. n.: growth and morphology in continuous culture. Amer. J. Bot. 57:649-658.

Sparrow FK Jr. 1933. Observations on operculate chytridiaceous fungi collected in the vicinity of Ithaca, N.Y. Amer. J. Bot. 20:63-77.

Sparrow FK Jr. 1942. A classification of aquatic Phycomycetes. Mycologia 34:113-116.

Sparrow FK Jr. 1943. Aquatic Phycomycetes, Exclusive of the Saprolegniaceae and *Pythium*. Univ. Michigan Press, Ann Arbor.

Sparrow FK Jr. 1958. Interrelationships and phylogeny of the aquatic Phycomycetes. Mycologia 50:797-813.

Sparrow FK Jr.. 1960. Aquatic Phycomycetes, 2nd ed. Univ. Michigan, Ann Arbor.

Sparrow FK Jr. 1973. Chytridiomycetes, Hyphochytridiomycetes. Pages 85-110 *in* The Fungi: An Advanced Treatise, IVB (G.C. Ainsworth et al., eds.). Academic Press, New York and London.

Stearn WT. 1983. Botanical Latin, 3rd ed. David & Charles, Newton Abbot, UK.

Whiffen AJ. 1944. A discussion of taxonomic criteria in the Chytridiales. Farlowia 1: 583-597.

Willoughby LG. 1957. Studies on soil chytrids. II. On *Karlingia dubia* Karling. Trans. Brit. Mycol. Soc. 40:9-16.

Willoughby LG. 1964. A study of the distribution of some lower fungi in soil. Nova Hedwigia 7:133-150 (plus 10 plates).

Willoughby LG. 1965. A study of Chytridiales from Victorian and other Australian soils. Arch. Mikrobiol. 52:101-131.

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A note on some morphological features of *Chorioactis geaster* (Pezizales, Ascomycota)

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Abstract–A study of *Chorioactis geaster* (Sarcosomataceae) has shown the presence of several unreported or unconfirmed characters for this unusual and rare operculate discomycete. The ascospores are ornamented, they mature more or less simultaneously in all asci of a single ascoma, and asci have a thin hyphal base. The species is compared with species of the genera *Cookeina* and *Microstoma* (Sarcoscyphaceae) that also have this character. SEM shows open asci have a two-layered opercular region confirming TEM reports of differentiated wall layering in this region of the ascus. These features are discussed and the isolated systematic position of *Chorioactis* suggested by previous studies is confirmed.

Key words–Ascus morphology, ascospore maturation, spore ornamentation

Introduction

Recently we showed that *Chorioactis geaster* (Peck) Kupfer ex Eckblad populations in Japan and North America represent distinct but closely related lineages. Molecular clock estimates suggest that they have probably been separate for at least 19 million years (Peterson et al. 2004). In the course of that study we examined a number of collections and determined that morphologically we could not distinguish the North American and Japanese collections. Our detailed studies, however, uncovered morphological features of the species that had not been noted previously. These observations are reported here.

The background and history of the genus *Chorioactis* Kupfer ex Eckblad was reviewed by Peterson et al. (2004). Previously considered to be a member of the Sarcosomataceae (Korf 1973), *C. geaster* was shown by Harrington et al. (1999) to be part of a weakly supported clade including species in the genera

Desmazierella Lib., *Neournula* Paden and Tylutki, and *Wolfina* Seaver ex Eckblad. These species have dark, roughened, superficial hairs on the outer surface of the ascomata (Eckblad 1968, Kupfer 1902). Unlike the central species of the Sarcosomataceae, however, their hymenia are not black but range in color from tan to butterscotch to orange. In this study we report our observations on *C. geaster*, especially those related to ascospore surface ornamentation and ascus morphology.

Materials and Methods

Material was studied using free-hand sections of fresh or dried ascomata. Portions of ascomata were rehydrated in tap water. Measurements and initial observations employed sections mounted in tap water. Subsequently, material was mounted in Congo Red in ammonia and cotton blue in lactic acid following Hansen et al. (2001). An Olympus BH-1 microscope was used for observations and photographs. Scanning Electron Microscopy (SEM) was done on an AM-RAY model 1000 SEM. Portions of hymenia of mature ascomata were mounted on stubs and sputter-coated with gold-palladium alloy.

Observations

Ascospore surface — Ascospores of *C. geaster* consistently have been described as smooth (Heald and Wolf 1910, Imazeki and Otani 1975, Seaver 1928, 1942). Close examination with the light microscope and subsequent SEM studies show that the spores are minutely punctate (Fig. 1 A-D). In a TEM study Bellèmere et al. (1994) indicated that the ascospore surface was marked, “Sa surface externe, irrégulière, forme de nombreuses petites protubérances ornementant.” Under the light microscope cyanophilic markings are detected in both fresh and dried material but they are particularly evident in freshly discharged ascospores. The markings are low and are not visible in optical sections. Additionally, they may be overlooked because they are obscured by the refractive, granular contents of the ascospores; these are lipids according to Bellemère et al. (1994).

Ascus maturation — In our study we found that all asci within a single ascoma had ascospores at more or less the same stage of development, that is, the ascospores develop synchronously. Synchronous ascospore maturation also is found in species in the genera *Cookeina* Kuntze and *Microstoma* Bernstein, in the family Sarcoscyphaceae. Further, we noted that the asci of *C. geaster* have a further shared feature with species of these two sarcoscyphaceous genera. Asci are constricted abruptly at the base (Fig. 2 A)

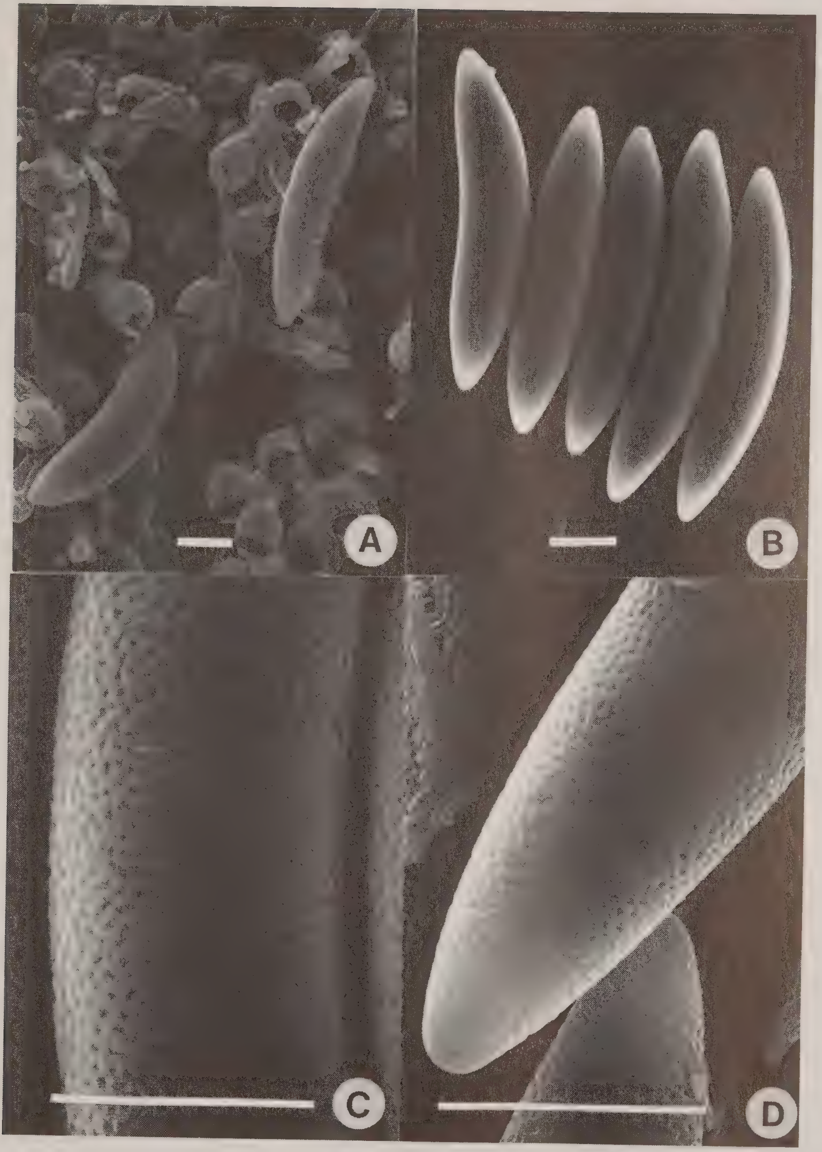

Fig. 1 A – D. SEM photographs of ascospores of *C. geaster*, scale bars in all figures = 10 μm. A. Ascospores lodged on the hymenial surface; note asci with prominent opercula. x 1000. B. Discharged ascospores, x 1200. C and D. View of surfaces of ascospores showing punctate wall ornamentation, x 5000.

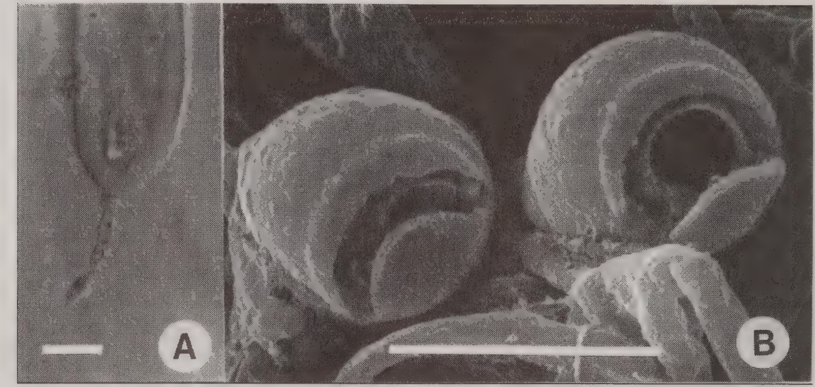

Fig. 2 A – B. Asci of *C. geaster*, scale bars in both figures = 10 μm. A. Light microscopic view of ascus showing hyphal base. B. SEM photograph of open asci, note opercula and the distinct wall layers at the region of dehiscence.

rather than tapering gradually as is the case with most other members of the order Pezizales. Imazeki and Otani (1975) describe and illustrate this feature with no comment. Similar bases are known in the Pezizales only in *Chorioactis geaster* and the previously mentioned members of the Sarcoscyphaceae. In some cases the hyphal base of the asci of *C. geaster* showed a thickened area or a globose intercalary swelling. Phylogenetic studies have placed *Cookeina* and *Microstoma* together in the family Sarcoscyphaceae; *Chorioactis* is only distantly related to these genera (Harrington et al. 1999). Although this ascus character may be useful in characterizing genera, it does not have broad phylogenetic value.

Operculum construction — The ascus tip opens via a thick-walled, somewhat eccentrically placed operculum. Our SEM studies indicated that a distinctive two-layered ring zone develops at dehiscence (Fig. 2 B). This configuration is evident in light microscopic examinations as well as in SEM. In TEM studies Bellemère et al. (1994) showed that the ascus lateral wall layering in *C. geaster* differs from other member of both the Sarcosomataceae and the Sarcoscyphaceae and suggested a somewhat isolated position for *C. geaster*. Additional evidence of such a view has been supported by molecular phylogenetic analyses (Harrington et al. 1999). We continue to work on the resolution of the placement of *Chorioactis* and its close relatives, *Desmazierella, Neournula* and *Wolfina.*

Acknowledgments

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Literature cited

Bellemère A, Meléndez-Howell LM, Chacun H, Melherbe MC (1994) Les asques du *Chorioactis geaster* (Ascomycetes, Pezizales, Sarcoscyphaceae), leur déhiscence et leurs ascospores: étude ultrastructurale. Nova Hedwigia 58:49–65

Eckblad F-E (1968) The genera of the operculate discomycetes: A re-evaluation of their taxonomy, phylogeny and nomenclature. Nytt Mag Botanik 15 (1-2):1-191

Hansen K, Læssøe T, Pfister DH (2001) Phylogenetics of the Pezizaceae, with an emphasis on *Peziza*. Mycologia 93:958-990

Harrington FA, Pfister DH, Potter D, Donoghue MJ (1999) Phylogenetic studies within the Pezizales. I. 18S rRNA sequence data and classification. Mycologia 91:41–50

Heald FD, Wolf FA (1910) The structure and relationship of *Urnula geaster*. Bot Gaz (Crawfordsville) 49:182–188

Imazeki R, Otani Y (1975) Rediscovery of *Chorioactis geaster* (Peck) Eckblad in Kyusyu, Japan. Trans Mycol Soc Japan 16:222-229.

Korf RP (1973) Discomycetes and Tuberales. The Fungi: An Advanced Treatise 4A:249-319.

Kupfer EM (1902) Studies on *Urnula* and *Geopyxis*. Bull Torrey Bot Club 29:137-144

Peterson KR, Bell CD, Kurogi S, Pfister DH (2003) Phylogeny and biogeography of *Chorioactis geaster* (Pezizales, Ascomycota) inferred from nuclear ribosomal DNA sequences. Harvard Pap Bot 8(2): in press.

Seaver FJ (1928) The North American Cup-fungi (Operculates). New York.

Seaver FJ (1942) The North American Cup-fungi (Operculates). Suppl. ed. New York

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Hypogeous fungi from the southeastern United States 3. The genus *Macowanites*

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Abstract—*Macowanites arenicola* is proposed and described as a new species. Information is provided on the ecology, morphology, anatomy and comparisons are made with related agaricoid taxa.

Key words—ectomycorrhiza, taxonomy, gasteroid, *Russulales,* Florida

Introduction

The genus *Macowania* was erected by Kalchbrenner (1876a) and emended by Kalchbrenner (1876b) to *Macowanites* to include fungi that have gasteroid basidiocarps resembling *Russula* that lack latex and possess a well-developed stipe-columella. Approximately 30 species have now been described (Singer & Smith 1960; Smith 1963; Beaton, Pegler & Young 1984; Cázares & Trappe 1991; Llistosella & Vidal 1995; Bougher & Syme 1998; Lebel & Trappe 2000; Calonge & Vidal 2001; Vidal, Calonge & Martín 2002) most of them from the western United States, Australia and New Zealand, although many more remain to be formally written up for publication from Argentina, Chile and elsewhere. No species have been recorded previously from the southeastern United States.

As a result of yearly visits to the coastal scrub habitat of northwestern Florida, Donna Mitchell and Bill Roody, two outstanding amateur mycologists from West Virginia, encountered a *Macowanites* species that had not been previously described. Interestingly, three species of *Macowanites* have recently been found in similar coastal dune habitat in Spain (Calonge & Vidal 2001; Vidal et al. 2002).

Materials and Methods

Methods of collection, terminology used, and classification were generally those of Singer and Smith (1960). Basidiospore size and shape were determined from optical sections in side view with the apiculus clearly evident and excluding the ornamentation. Color names and descriptions were taken from the Methuen Handbook of Colour (Kornerup & Wanscher 1981). Herbarium names are abbreviated according to Holmgren, Holmgren & Barnett (1990). Fresh and dried specimens were examined with standard microchemical reagents useful in the genus (Singer & Smith 1960).

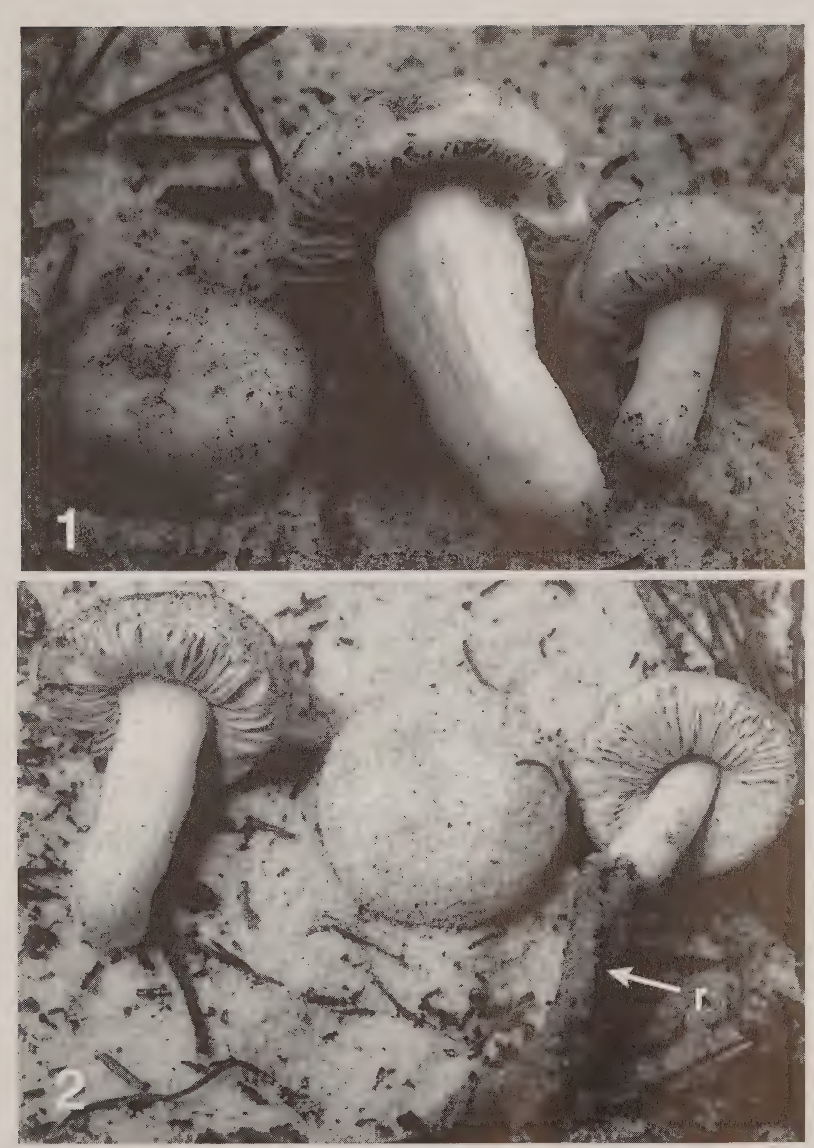
Taxonomic Description

Macowanites arenicola S.L. Mill. & Mitchell FIGURES **1–2, 3–8**

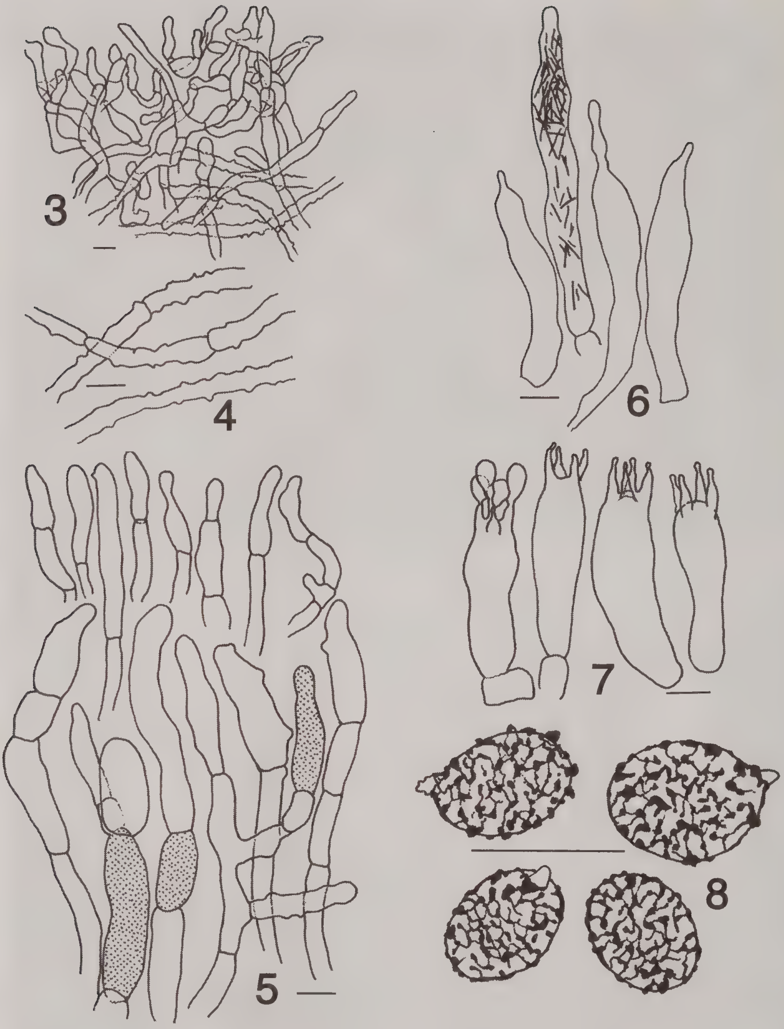
> *Basidiomata gregaria, hypogaea ad erumpentia, stipitata. Pileus 2–2.5 cm in diam., laevis, viscidus vel siccus, granis arenae adhaerentibus conspersus, albidus ad pallide rosaceo-aurantiacus, maculis luteolis notatus. Stipiti-columella percurrens, 1.5–2.5 x 0.6-1.2 cm, alba, interdum canescens, ubi contusus immutabilis; extensio basis stipitis e mycelio, arena, radicibusque constans, facile disrupta; contextus albus solidus demum loculatus vel cavus. Gleba convoluta vel in parte superiore loculata, sublamellata ubi exposita prope marginem, luteola ad flava. Sporae 8.8–10.4 (10.8) x 6.8-7.2 µm, Q = 1.37, late ellipticae ad ellipticae, heterotropicae, appendiculo hilari, ornatae reticulo tenui fracto e connectivis humilibus saepe cristatis et verrucis humilibus 0.2–0.4 µm altis constanti, plaga parva irregulari, saepe ad collum ad basin appendiculi hilaris redacta vel nulla.*
>
> *Fructificat in arenis albis quartziticis Floridae a mense Decembri ad Februarium in sylvis apertis pini quercusque cum Pino clausa, P. elliottii, Quercu myrtifolia, Q. geminata et Q. virginiana. Holotypus: Florida, Comitatus Gulf, Caput San Blas, die 8 Februarii 1999, a Donna Mitchell et Bill Roody lectus DMFL 99-3 (RMS).*
>
> ***Etymology:*** Latin *(arenicola,* sand-dwelling*),* referring to the white quartz sand common in the coastal scrub forests of northwestern Florida were it grows.

Basidiocarps: gregarious, hypogeous to erumpent, stipitate. **Pileus** 2–4.5 cm diam, convex to broadly convex, margin decurved or rarely involute; smooth, tacky or dry, with adherent granules of sand, not touching stipe but occasionally covering gleba in places, peeling one-half to completely; whitish to pale buff (4B–3), occasionally mottled with yellowish white (4A-2) to pale yellow (4A–3) or rarely pinkish (9A–3 to 9B–3). **Stipe-columella:** percurrent, cylindrical or tapering slightly toward the base, 1.5–2.5 x 0.5–1.2 cm, low longitudinal ridges, white, occasionally with greyish cast to the ridges, unchanging when bruised; extension of stipe base consisting of mycelium, sand and ectomycorrhizal roots, easily disarticulated; context white, initially solid, then chambered or hollow. **Gleba:** convoluted to loculate in the upper zone, sublamellate or rarely lamellate where exposed near the margin, pale to light yellow or pale ochraceous (4A3–5). **Odor:** of old yogurt or soy sauce. **Taste:** mild. **Macrochemical reactions:** not noted.

Spores: 8.8–10.4 (10.8) x 6.8–7.2 μm (excl. orn.), Q= 1.37, broadly elliptical to elliptical, mostly heterotropic, with a hilar appendage. Ornamentation a fine broken reticulum of low often cristate connectives and low verrucae 0.2–0.4 μm high, plage small, irregular, often reduced to a collar at base of hilar appendage or absent, hyaline to pale yellow in KOH, ornamentation amyloid in Melzer's reagent, hilar appendix 3–4 x 2.5–4.0 μm, conical, often with a ragged terminal hilar scar. **Hymenial elements**: basidia 42–52 x 7–9 μm, clavate, bearing 4 spores, sterigmata 4–6 μm long, tapering toward the apex, usually curving; macrocystidia scattered but moderately abundant in localized patches, 80–120 x 6–7.5 μm, mucronate to ventricose-rostrate, with short simple



Figs. 1–2. *Macowanites arenicola* (FLDM99–3), x 2. 2. *Macowanites arenicola* (DMFL–2), x 2.5. The arrow at “r” denotes an extension of the stipe base consisting of mycelium, sand and ectomycorrhizal roots (photo by Bill Roody).



Figs. 3–8. Microscopic spore and peridium features of *Macowanites arenicola* from the southeastern United States. Scale bars = 10 μm. 3. Pileipellis *(DMFL–2)* composed of large articulated dermatocystidia and smaller hyphal end cells. 4. Ornamented hyphae frequent in the subpellis *(FLDM 99–13)*. 5. Elements of the pileipellis. 6. Pleuromacrocystidia. Crystals in second cystidium from the left are indicative of sulfovanillin staining. 7. 4-sterigmate basidia. 8. Basidiospores with fine amyloid reticulate ornamentation and plage reduced to amyloid collar on hilar appendage or absent.

or long strangulated rostrum, hyaline in KOH, dark grey-black in sulfovanillin with crystalline contents. **Hymenophoral trama:** regular or nearly so, of interwoven, subparallel hyphae 3–7 μm diam with large inflated, isodiametric, thin-walled cells 15–20 μm scattered throughout, laticiferous hyphae infrequent 7–12 μm diam, cylindrical to swollen and contorted, thin-walled, with yellowish refractive contents in KOH. **Subhymenium:** subcellular to cellular, 1–2 cells thick, cell diam. 12–20 μm. **Pileipellis**: Epicutis 190–250 μm thick, a trichodermial layer of branching interwoven hyphae in a gelatinous matrix, terminal cells clavate, obclavate to ventricose, 2.5–3 μm, mixed with large articulated dermatocystidia, terminal cells cylindrical, claviform to obclavate or ventricose, 5–7 μm, frequently with irregular short pseudobranches; subcutis not well defined, containing periclinally arranged hyphae 3–4 μm, with irregular wall processes, laticiferous hyphae infrequent, 7–12 μm diam. **Context**: of pileus and stipe heteromerous with nested sphaerocytes up to 50 μm.

Habitat and season: Fruiting in the white quartzite sands of the Florida northwestern coastal scrub forests from December to March associated with open *Pinus* and *Quercus* woodlands containing *Pinus clausa, P. elliotii, Quercus myrtifolia, Q. gemata* and *Q. virginiana.*

MATERIAL EXAMINED—USA. **HOLOTYPE:** FLORIDA: **Gulf Co.**, CAPE SAN BLAS, 8 February 1999, Donna Mitchell and Bill Roody DMFL 99-3 (RMS); other collections: **Gulf Co.**, CAPE SAN BLAS, 16 January 2000, Donna Mitchell and Bill Roody 2610, (RMS, DEWV); 20 February 2000, 2612 (DEWV); 25 January 2001, 2611 (DEWV); 3 February 2001, 2613 (RMS, DEWV); **Franklin Co.**, MAGNOLIA CEMETERY, APALACHICOLA, 26 December 2002, Donna Mitchell and Bill Roody 3633, (RMS, DEWV); **Bay Co.**, CROOKED ISLAND, 27 January 2003, Donna Mitchell and Bill Roody 3632, (DEWV).

Discussion

Macowanites arenicola is locally common in the early winter months in the coastal scrub forests of northwestern Florida. It can be found below the surface or may be erumpent through the sand. This fungus is undoubtedly ectomycorrhizal, as the extension of the stipe columella often contains ectomycorrhizal rootlets along with masses of mycelia and sand, but it is unknown whether it is associated with both pines and/or the live oaks in the area.

The distinction between *Macowanites* and *Russula* is tenuous at best. The chambered, loculate or "gasteroid" condition of the hymenophore is the single character that is most useful in separating the genera, however there is a great deal of plasticity in this character in both genera. Because of ongoing molecular studies in the *Russulaceae* which suggest that gasteroid taxa do not appear in all infrageneric taxa of *Russula*, we prefer to place this fungus in the genus *Macowanites* for the present time. *Macowanites arenicola* collections observed in the drier growing season of 2003 tended to be much more lamellate than those observed at the same collecting locales in previous years. A similar condition has been observed in *M. messapicoides* Llistosella & Vidal and *Russula messapica* Sarnari (Martín, Högberg & Llistosella 1999). Molecular evidence (Miller *et al.* 2001) indicates that *Macowanites* is polyphyletic, with different species aligning with disparate clades representing well accepted infrageneric taxa within *Russula*.

Based on microscopic characters, *M. arenicola* would be placed in the subsection *Cupreinae* of Bon. The base tissue of the pileipellis is composed of narrow, branching hyphae with tapering or ventricose terminal cells. Mixed through this basic ground tissue are the distinctive large multicelled or articulated dermatocystidia that subtly stain greyish in sulfovanillin and frequently have irregular knobby projections. Microscopically, the pileipellis is similar to *R. cupreola* Sarnari. The relatively thin spore wall with ornamentation composed of scattered verrucae and fine, incomplete and cristulate reticulum is typical for many members of the *Cupreinae* except that the plage is somewhat underdeveloped in *M. arenicola*. Other members of the *Cupreinae* such as *R. cuprea* typically have ornamentation composed of isolated verrucae or warts with a well developed, darkly amyloid plage.

Acknowledgements

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Literature Cited

Beaton G, Pegler DN, Young TWK. 1984. Gasteroid basidiomycota of Victoria State, Australia 2. Russulales. Kew Bull. 39: 669–698.

Bougher NL, Syme K. 1998. Fungi of Southern Australia. University of Western Australia Press, Nedlands, Western Australia. 391 pp. 1998.

Calonge FD, Vidal JM. 2001. *Macowanites vinaceodorus sp. nov.*, (Russulales) a new gasteroid fungus from coastal dunes of Spain. Mycotaxon 79: 1–6.

Cázares E, Trappe JM. 1991. Alpine and subalpine fungi of the Cascade and Olympic Mountains. 2. *Macowanites lymanensis* sp. nov. Mycotaxon 42: 333–338.

Holmgren P, Holmgren N, Barnett LC. 1990. Index Herbariorum part I. *The Herbaria of the World.* Regnum Vegetabile 120: 1–693.

Kalchbrenner K. 1876a. *Macowania* Kalchbr. gen. nov. Gardeners Chronicle 5 (NS), 785.

Kalchbrenner K. 1876b. *Macowanites agaricinus* gen. nov., sp. nov. Hedwigia 15: 115–116.

Kornerup A, Wanscher JH. 1981. *Methuen Handbook of Colour*. 3rd ed. Eyre Methuen, London, 252 p.

Lebel T, Trappe JM. 2000. Type studies of sequestrate Russulales. I. Generic type species. Mycologia 92: 1188–1205.

Llistosella J, Vidal, JM. 1995. Due nuove specie de Russulales gasteroidi della regione mediterranea. Riv. Mic. AMB 38: 149–162.

Martín MP, Högberg N, Llistosella J. 1999. *Macowanites messapicoides*, a hypogeous relative of *Russula messapica*. Mycol. Res. 103: 203–208.

Miller SL, McClean TM, Walker JF, Buyck B. 2001. A molecular phylogeny of the Russulales including agaricoid, gasteroid and pleurotoid taxa. Mycologia 93: 344–354.

Singer R, Smith AH. 1960. Studies on secotiaceous fungi. IX. The Astrogastraceous series. Memoirs of the Torrey Botanical Club 21: 1–112.

Smith AH. 1963. New astrogastraceous fungi from the Pacific Northwest. Mycologia 55: 421–441.

Vidal JM, Calonge FD, Martín MP. 2002. *Macowanites ammophilus* (Russulales) a new combination based on new evidences. Rev. Catalana Micol. 24: 69–74.

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Lactarius in Kumaon Himalaya 2: New and interesting species of subgenus *Plinthogali*

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Abstract—*Lactarius montoyae* proposed as new to science and *L. lignyotus* var. *canadensis* reported for the first time from India are described and illustrated here.

Key words—Macrofungi, *Russulaceae,* taxonomy, ectomycorrhizae, India

Introduction

The subgenus *Plinthogali* (Burl.) Hesler & A.H. Smith, a well defined group in the genus *Lactarius,* is characterized as follows: pileus dry, velvety to unpolished, typically blackish, fuscous, date-brown, alutaceous, dingy buff or dull white; latex milk white, cream or rarely brown, unchanging or changing to reddish cinnamon, vinaceous red, reddish brown, lilac or violaceous or staining injured areas with these colours; true cystidia mostly absent; pileipellis a trichoderm, less frequently a cellular subpellis and with a turf as suprapellis. Hesler & Smith (1979) divided the subgenus into two sections, viz., sect. *Plinthogali* and sect. *Fumosi* Hesler & A.H. Sm. Practically, this classification was rather artificial and quite inapplicable. Further, Verbeken (2000) during the studies on tropical African mycoflora emended the definition of the subgenus and divided it into three sections, viz., sect. *Nigrescentes* Verbeken (so far comprising only African representatives), sect. *Pseudofuliginosi* Verbeken and sect. *Plinthogali.* During the macrofungal investigation in Kumaon, Himalaya, authors collected two interesting taxa of this subgenus under the sect. *Plinthogali*. One appears as an undescribed taxon and is proposed here as *Lactarius montoyae*, whereas, another one, *L. lignyotus* var. *canadensis* is not yet recorded from India.

Materials and Methods

The present communication is based on the repeated surveys undertaken to Pindari and Sunderdhunga Glaciers and surrounding forests of Kumaon Himalaya during September-October in 1999 and 2003 respectively.

Macromorphological characters were noted from the fresh specimens in the field. Micromorphological characters were studied with the dried material mounted in 5% KOH, Melzer's reagent, Lactophenol-cotton blue or carbol fuchsin. Colour terms mentioned are from Kelly & Judd (1955). All the line drawings were made by K. Das. Microscopic line drawings were prepared with the aid of the camera lucida attachment at original magnification of 1500x for basidiospores, 1000x for cystidia and basidia, 500x for other microstructures. Density of lamellae was measured at the margin excluding lamellulae. Basidiospore length excludes the length of ornamentation. Basidium length excludes the length of sterigmata. For measurement of basidiospores, 20 basidiospores were observed. Quotient (Q = L/W) was calculated considering the mean value of length and width. Different terms regarding cystidia are after (Heilmann-Clausen et al., 1998). Herbarium name used is following Holmgren et al. (1990).

Results

Including the two taxa discussed here, subgenus *Plinthogali* is represented by 12 taxa (Atri et al. 1994, Das & Sharma 2002) in India. Among them only five i.e. *L. subisabellinus* var. *murrillianus* (Hesler & A.H. Sm.) Hesler & A.H. Sm., *L. picinus* Fr., *L. gerardii* Peck var. *subrubescens* (A.H. Sm. & Hesler) Hesler & A.H. Sm., *L. montoyae* and *L. lignyotus* var. *canadensis* are hitherto known from Kumaon Himalaya.

Provisional key to the species from Kumaon Himalaya

1a. Pileipellis colour light brown, pileipellis not distinct in two layers; fresh cut lamellae unchanging .... *L. subisabellinus* var. *murrillianus*

b. Pileipellis colour gray to dark gray yellowish brown, grayish to deep grayish brown, brownish black, dark olive brown, pileipellis of distinctly two layers; fresh cut lamellae changing or unchanging.......................... 2

2a. Spore ornamentation 2–2.7 μm high; never reticulate .... *L. montoyae*

b. Spore ornamentation not more than 2 μm high, forming incomplete to almost complete reticulum... 3

3a. Pileus papillate; pleuromacrocystidia present .... *L. lignyotus* var. *canadensis*

b. Pileus not papillate; pleuromacrocystidia absent...................................... 4

4a. Pileus areolate at maturity; lamellae subdistant to distant, medium pink on bruising .... *L. gerardii* var. *subrubescens*

b. Pileus never areolate; lamellae rather crowded, dark reddish brown on bruising .... *L. picinus*

Lactarius montoyae K. Das & J.R. Sharma *sp. nov.* **Figure 1, a–h**

Etymology: In recognition to Dr. L. Montoya for her contributions to the genus *Lactarius.*

*Pileus 30–60 mm diam., convexus, planoconvexus ad applanatus, leviter depressus in centro, interdum umbonatus, atrobrunneus, margine leviter decurvato. Lamellae adnatae ad subdecurrentes, distantes, pallide ochraceae ad luteae. Stipes 25–58 x 7–12 mm, cylindratus, pileo concoloratus. Sporae in cumulo pallide ochraceae ad luteae, globosae ad late ellipsoidae, amyloideae, alatae, cristis usque ad 2.7 µm altis ornatae. Pleuromacrocystidia absentia. Pleuropseudocystidia abundantia. Paracystidia 45–56 x 8–11 µm, subclavata. Pileipellis bistrata; elementa suprapellis cylindrata, longa, 18–65 x 4–9 µm; subpellis ex cellulis sphaeris. INDIA, Uttaranchal, Bageswar, Dhakuri, September 29, 1999, leg. K. Das & J.R. Sharma, KD1065 (**holotypus**, BSD).*

Pileus 30–60 mm diam., convex, planoconvex to applanate or slightly planoconcave at maturity; center sometimes depressed and often with an umbo; pileipellis pruinose to velutinous, dry, gray yellowish to dark gray yellowish brown, grayish to deep grayish brown; margin slightly decurved or plane, sometimes broadly wavy, often crenate in older specimens. **Lamellae** adnate or / to subdecurrent, distant (*ca* 4 per cm), edge smooth, concolorous, pale ochre to orange yellow, unchanging when bruised; lamellulae of different sizes. **Stipe** 25–58 x 7–12 mm, central or slightly eccentric, cylindric or slightly tapering downwards, sometimes slightly grooved longitudinally, glabrous, dry, concolorous, often yellowish white at the base. **Context** stuffed to hollow, yellowish white. **Latex** rather sparse, white, unchanging. **Odor** mild. **Spore print** pale yellow ochre to orange yellow.

Basidiospores 7.5–10.0 (10.3) x (7.0) 7.3–9.3 µm, globose to broadly ellipsoid [Q = 1.03–1.15 (1.2), av. 1.06–1.09]; ornamentation amyloid, up to 2.7 µm high, composed of ridges arranged in somewhat parallel and / or in a spiral pattern, rarely branched, never reticulate; often shorter ridges occupying the gap between the main ridges; plage amyloid. **Basidia** 44–60 x 9–12.5 µm, subclavate to clavate, 4-spored; sterigma up to 7.5 µm long. **Pleuromacrocystidia** absent. **Pleuropseudocystidia** up to 8.5 µm broad, abundant, mostly cylindrical with rounded apex. Lamellae edge sterile. **Cheilomacrocystidia** absent. **Paracystidia** 45–56 x 8–11 µm, subclavate to clavate, sometimes narrower towards apex. **Hymenophoral trama** mixed, composed of hyphae, sphaerocytes and laticifers. **Pileipellis** a trichopalisade, up to 110 µm thick; terminal elements of suprapellis, cylindrical to ventricose, long, slender, 18–65 x 4–9 µm, thin walled, with brown intracellular pigmentation; subpellis composed of mostly globose cells, up to 27 µm diam. **Stipitipellis** a trichopalisade; terminal elements of suprapellis, cylindrical, slender, 15–50 x 3–7 µm, thin walled, with brown intracellular pigmentation; subpellis of globose cells. **Stipe trama**

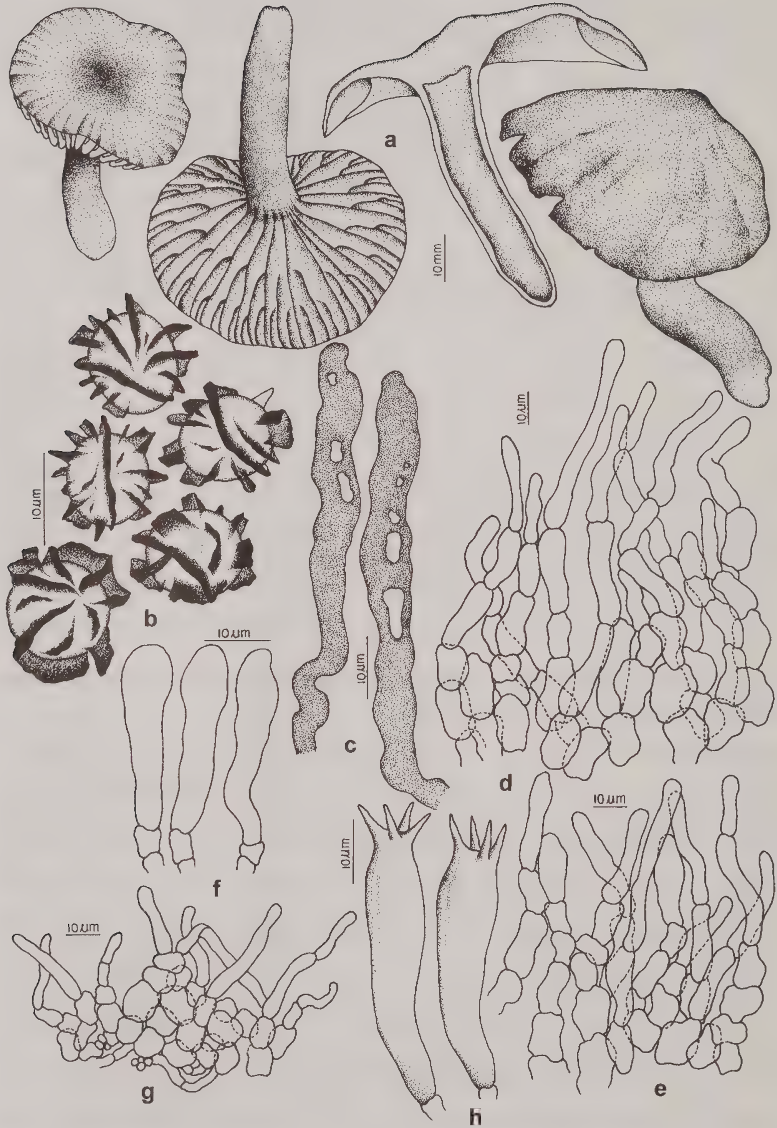
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Fig. 1. *Lactarius montoyae* (from holotype). a. Basidiomes. b. Basidiospores. c. Pleuropseudocystidia. d, e. Cross-section of pileipellis. f. Paracystidia. g. Cross-section of stipitipellis. h. Basidia.

with numerous sphaerocytes.

Ecology — *Lactarius montoyae* grows preferably among mosses, forming ectomycorrhizal association with species of *Quercus* and *Rhododendron* in moist deciduous to mixed temperate (2500–3000 m) forests.

Notes — *Lactarius montoyae* is a rare species and was repeatedly collected only from the forests surrounding Dhakuri. *Lactarius romagnesii* Bon. with which the present taxon closely resembles regarding the basidiome morphology and high spore ornamentation, differs in having globose to broadly ellipsoid spores with the ornamentations forming a reticulate pattern (Heilmann-Clausen *et al.*, 1998) and shorter (10–35 x 4–9 µm) terminal elements of suprapellis. Microscopically, *L. montoyae* is also close to *L. pterosporus* Romagn. However, the pileus of *L. pterosporus* is strongly wrinkled in the center at maturity, "olivaceous buff to dark grayish buff or clay-buff" coloured (Heilmann-Clausen et al., 1998), lamellae are crowded and latex is white which turns pale grayish pink on drying on the flesh, not turning colour when isolated from flesh.

MATERIAL EXAMINED — INDIA. Uttaranchal: Bageswar, Dhakuri, September 29, 1999, leg. K. Das & J.R. Sharma, KD1065 (**holotype**, BSD); *ibid.*, September 16, 2003, leg. K. Das, KD7003 (BSD); *ibid.*, Dhakuri top, September 25, 2003, leg. K. Das & J.R. Sharma, KD7080, KD7081 (BSD).

Lactarius lignyotus Fr. var. ***canadensis*** A.H. Sm. & Hesler, Brittonia 14: 398 (1962). **Figure 2, a–i**

Pileus 40–75 mm diam., convex, becoming slightly depressed in the center with a papilla; pileipellis wrinkled, somewhat felty, dark grayish brown to brownish black; margin decurved, sulcate to irregularly loabed at maturity. **Lamellae** subdistant to distant (*ca* 4–5 per cm), sometimes intervenose, cream to pale ochre, pinkish when injured; lamellulae of different sizes; edge brownish black. **Stipe** 34–50 x 7–9 mm, dry felty, cylindric mostly concolorous or slightly paler towards base. **Context** hollow, yellowish white, slowly pinkish at the base. **Latex** white, unchanging. **Odor** indistinct. **Taste** mild. **Spore print** pale ochre or buff.

Basidiospores 8.5–11 x 8.2–9.7 µm, globose to subglobose (Q = 1.00–1.14, av. 1.01–1.04); ornamentation amyloid, up to 2 µm high, composed mostly of irregular ridges with spiny extremes, forming an incomplete reticulation, plage amyloid. **Basidia** 35–52 x 11–14 µm, subclavate, 4-spored; sterigma up to 7 µm long. **Pleuromacrocystidia** 55–64 x 9–11 µm, rare, subfusoid to ventricose. **Pleuropseudocystidia** up to 7 µm broad, cylindrical. Lamellae edge sterile. **Cheilomacrocystidia** 18–54 x 4–11 µm, abundant, clavate,

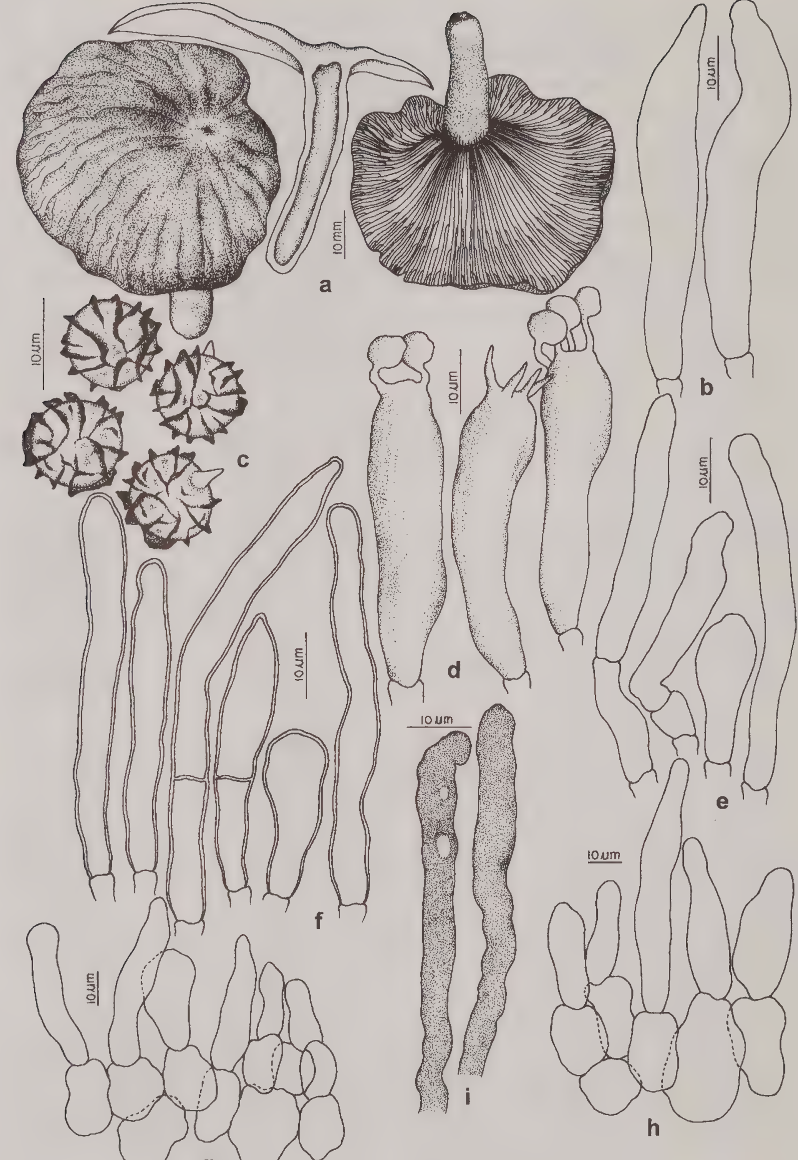
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Fig. 2. *Lactarius lignyotus* var. *canadensis* (from KD7006). a. Basidiomes. b. Pleuromacrocystidia. c. Basidiospores. d. Basidia. e. Cheilomacrocystidia. f. Caulocystidia. g, h. Cross-section of pileipellis. i. Pleuropseudocystidia.

ventricose or cylindric, with brown intracellular pigmentation. **Pileipellis** a hymeniderm, composed of short chains of vesiculose cells; terminal cells 19–42 x 9–18 μm, cylindrical to clavate, thin walled, with brown intracellular pigmentation. **Stipitipellis** with numerous cystidia. **Caulocystidia** 16–90 x 6–13.4 μm, cylindrical to clavate with brown intracellular pigmentation; wall up to 1 μm thick. **Stipe trama** with abundant sphaerocytes.

Ecology — *Lactarius lignyotus* var. *canadensis* grows preferably among mosses and ectomycorrhizally with species of *Quercus* and *Rhododendron* in moist deciduous subtropical to temperate (2000–2800 m) Himalayan forests.

Notes — *Lactarius lignyotus* var. *canadensis* is also not common in Kumaon Himalaya and is readily recognized by its papillate pileus, radially wrinkled pileipellis, distinctly margined lamellae and mild taste. Besides, the habitat (among the mosses), pinkish stipe base after cutting, presence of pleurocystidia and wider caulocystidia make the present taxon distinct among the other taxa in this subgenus. It resembles *L. gerardii* Peck var. *subrubescens* (Smith & Hesler) Hesler & Smith closely. But the latter has only 1–2 rows of lamellulae, up to 0.6 μm thick basidiospore ornamentations and no pleuromacrocystidia.

MATERIAL EXAMINED — INDIA. Uttaranchal: Bageswar, Dhakuri, September 16, 2003, leg. K. Das, KD7006 (BSD); *ibid.*, Champawat, Mayawati, October 6, 2002, leg. K. Das & J.R. Sharma, KD5000 (BSD).

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Literature Cited

Atri NS, Saini MK, Saini SS. 1994. Indian *Russulaceae* Roze — A check list. In: TA Sharma, SS Saini, ML Trivedi, M Sharma (eds.), Current Researches in Plant Sciences, pp. 81–93. Bishen Singh Mahendra Pal Singh, Dehradun, India.

Das K, Sharma JR. 2002. The genus *Lactarius* in India. Bull. Bot. Surv. Ind. 44 (in press).

Heilmann-Clausen J, Verbeken A, Vesterholt J. 1998. The genus *Lactarius*. The Danish Mycological Society.

Hesler LR, Smith AH. 1979. North American Species of *Lactarius*. The University of Michigan Press.

Holmgren PK, Holmgren NH, Barnett LC. 1990. Index Herbariorum. Part 1: Herbaria of the world, 86th ed. Brox: New York Botanical Garden.

Kelly KL, Judd DB. 1955. The ISCC-NBS Method of Designating Colors and a Dictionary of Colour Names. ISCC-NBS Color-Name Charts Illustrated with Centroid Colors. National Bureau of Standards Circular 553. U.S. Government Printing Office, Washington, DC.

Verbeken A. 2000. Studies in Tropical African *Lactarius* Species 8. A synopsis of the subgenus *Plinthogali*. Persoonia 17(3): 377–406.

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Two new Hyphomycetes from rainforests of México, and *Briansuttonia*, a new genus to accommodate *Corynespora alternarioides*

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Abstract—*Corynespora aquatica* anam. sp. nov. on decaying leaves of an unidentified plant submerged in a stream, and *Solicorynespora sylvatica* anam. sp. nov. on leaf litter, both found in tropical rainforests, are described and illustrated. *Solicorynespora mulanjeensis* comb. nov. is proposed, and a key to *Solicorynespora* species is provided. *Briansuttonia* gen. nov. is established to accommodate *Corynespora alternarioides*.

Key words—submerged leaves, systematics, tropical fungi.

Introduction

Over 40 hyphomycetes were collected during two mycological surveys of conidial fungi from tropical plant material in several undisturbed rainforests of Los Tuxtlas (Veracruz) and Chajul (Chiapas), México. Among the collections were two conspicuous fungi clearly related to the genera *Corynespora* Güssow (Siboe & Kirk, 1999) and *Solicorynespora* R.F. Castañeda & W.B. Kendr. (1990). They appear to be new to Science.

The genus *Corynespora* is characterized by monotretic, terminal conidiogenous cells which undergo percurrent enteroblastic proliferation. Conidiogenous loci are apical, slightly depressed, somewhat melanized around the pore to produce solitary or catenate, multi-distoseptate, obclavate, cylindrical, obovate, oval to irregular, smooth-walled or verruculose, pale brown to pale olivaceous brown conidia, usually with a slightly melanized basal scar.

Corynespora cassiicola (Berk. & M.A. Curtis) C.T. Wei 1950, the type species, shows great variability in conidial morphology and can be found on a wide range on substrata as a plant pathogen or as a saprobe on decaying plant material. The illustrations provided by Wei (1950) of *C. cassiicola* from several collections on different substrata can be compared with many other species described in *Corynespora* such as: *C. heterospora* J.M. Yen 1980, *C. eranthemi* J.M. Yen & Lim 1980, *C. hemigraphidis* J.M. Yen & Lim 1980 and *C. ruelliae* J.M. Yen & Lim 1980, *C. longispora* Sarboy & Saikia 1980, *C. ligustri* Y.L. Guo 1984, *C. merremiae* Y.L. Guo 1984, *C. millettiae* Y.L. Guo 1984 and *C. viticis* Y.L. Guo 1984. All of them show a conidial morphology somewhat similar or strongly related to *C. cassiicola* as was suggested by Morgan-Jones (1988). However, the latter author did not synonymize them, and molecular studies may be needed to clarify their affinities and differences. Castañeda Ruíz and Kendrick (1990) introduced the genus *Solicorynespora* for species with tretic and percurrently proliferating conidiogenous cells analogous to *Corynespora* species, but with euseptate conidia. Similar criteria were adopted for the genera *Ellisembia* Subram. 1992 and *Sporidesmiella* P.M. Kirk 1982 to segregate species with distoseptate conidia and a conidial ontogeny similar to *Sporidesmium* Link 1809 (Ellis 1971, 1976), but with enteroblastic percurrent proliferation marked with annellations during conidiogenesis.

Taxonomy

Corynespora aquatica R.F. Castañeda, Heredia et Arias, anam. sp. nov.

FIGURES 1-2

Ad fungos conidiales, hyphomycetes pertinens. ***Coloniae*** *in substrato naturali effusae pilosae, amphigenae, brunneae; mycelium plerumque in substrato immersum, ex hyphis septatis, ramosis, laevibus, brunneis usque pallide-brunneis, 1.5–2.5 µm diam., compositum.* ***Conidiophora*** *conspicua, mononemata, erecta, recta, raro flexuosa, cylindrica, leviter clavata ad apicem, 1- ad 4-septata, laevia, brunnea, 49–68 x 3–4 µm, ex cellula basali radiatim lobata orientes.* ***Cellulae conidiogenae*** *uniloculosae, treticae, terminales, brunneae, 7–12 x 3–3.5 µm, plerumque determinatae, interdum 1 proliferatione enteroblastica percurrenti praeditae.* ***Loci conidiogeni*** *pori apicales.* ***Secedentia conidiorum*** *schizolytica.* ***Conidia*** *obclavata usque ad* cylindrica, solitaria, *acrogena, (1- ad) 2- (ad 3-) distoseptata, 34–46 x 3.0–4.5 µm, pallide brunnea, laevia, sicca. Teleomorphosis ignota.*

Etymology: Latin, *aquaticus* refers to its growing in water.

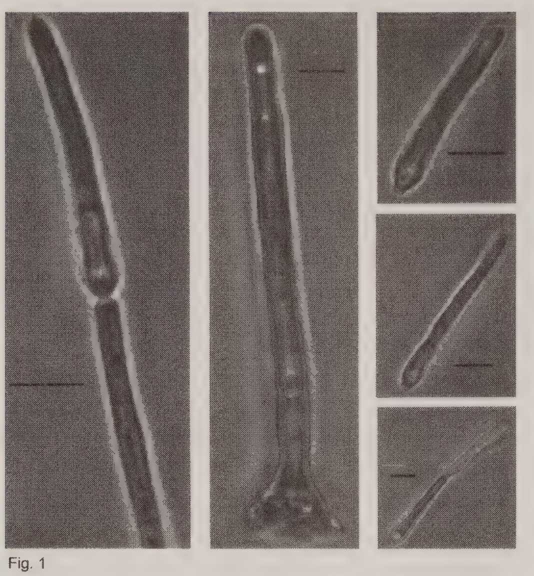

Fig. 1

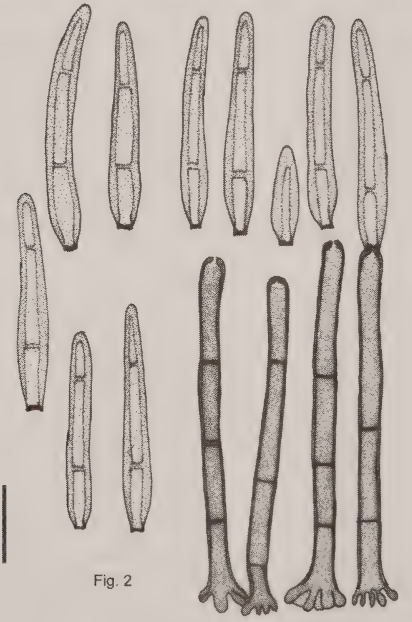

Fig. 2

Figs. 1-2. *Corynespora aquatica*. Conidiophores, conidiogenous cells and conidia. **Fig. 1**: Micrographs. **Fig. 2**: Drawings. Scale is indicated by bar (10 μm).

Conidial fungi, hyphomycetes. **Colonies** on the natural substrate effuse, hairy, amphigenous, brown; mycelium mostly immersed composed of septate, branched, smooth-walled, 1.5–2.5 diam., pale brown to brown hyphae. **Conidiophores** differentiated, mononematous, erect, straight, rarely flexuous, slightly clavate towards the apex, 1- to 4-septate, smooth-walled, brown, 49–68 × 3–4 μm; arising from a radially lobed basal cell. **Conidiogenous cells** unilocal, tretic, terminal, brown, 7–12 × 3–3.5 μm, mostly determinate, but sometimes with an enteroblastic, percurrent proliferation. **Conidiogenous loci** an apical pore. **Conidial secession** schizolytic. **Conidia** obclavate to cylindrical, solitary, acrogenous, (1- to) 2- (to 3-) distoseptate, 34–46 × 3.0–4.5 μm, pale brown, smooth-walled, dry. **Teleomorph**: unknown. **Matrix:** on decaying leaves submerged in a stream, in the rainforest `Los Tuxtlas´, Veracruz, México, leg. R.M. Arias, J. Yadeneiro de la Cruz Elizondo & R.F. Castañeda, 19. V. 2002 (**Holotype**- XAL CB742, Instituto de Ecología, Xalapa, Veracruz, México).

COMMENTS: Among described *Corynespora* spp. listed by Siboe & Kirk (1999) the new species resembles only *C. matuszakii* Morgan-Jones 1988, which has 2- to 10-distoseptate conidia, 56–260 × 10.0–12.5 μm in size, formed solitary or in a chain, whereas those of *C. aquatica* are always solitary, mostly 2-distoseptate and smaller.

Solicorynespora sylvatica R. F. Castañeda, Heredia, Arias et Guarro, anam. sp. nov.
FIGURES 3-4

*Ad fungos conidiales, hyphomycetes pertinens. **Coloniae** in substrato naturali effusae pilosae, hypophyllae, brunneae; mycelium plerumque in substrato immersum, ex hyphis septatis, ramosis, laevibus, brunneis usque pallide-brunneis, 1–2 μm diam., compositum. **Conidiophora** conspicua, mononemata, erecta, recta vel leviter flexuosa, cylindrica, leviter clavata ad apicem, 2- ad 7-septata, laevia, brunnea, 30–120 x 5–7 μm. **Cellulae conidiogenae** uniloculosae, treticae, terminales, brunneae, 8–15 x 3–5 μm, determinatae vel indeterminatae, interdum 1–2 proliferationibus enteroblasticis percurrentibus praeditae. **Loci conidiogeni** pori apicales. **Secedentia conidiorum** schizolytica. **Conidia** obpyriformia usque ad obclavata, longissima rostrata, solitaria, acrogena, 3- ad 6-euseptata, 35–67 x 5–7 μm (rostro incluso), brunnea, pallide-brunnea vel ad apicem subhyalina; laevia, sed quaeque in cellula basali verruculosa; rostro 30–50 x 1.5–2.0 μm induta. Teleomorphosis ignota.*

Etymology: Latin, *sylvatica*, refers to a forest inhabitant growing wild.

Conidial fungi, hyphomycetes. **Colonies** on the natural substrate, effuse, hairy, hypophyllous, brown; mycelium mostly immersed, composed of septate, branched, smooth-walled, brown to pale brown hyphae, 1–2 μm diam. **Conidiophores** differentiated, mononematous, erect, straight, or slightly flexuous, cylindrical, slightly clavate towards the apex, 2- to 7-septate, smooth-walled, brown, 30–120 × 5–7 μm. **Conidiogenous cells** unilocal, tretic, terminal, brown, 8–15 × 3–5 μm, determinate or indeterminate, sometimes with 1–2 enteroblastic percurrent proliferations. **Conidiogenous loci** an apical pore. **Conidial secession** schizolytic. **Conidia** obpyriform to obclavate, very long rostrate, solitary, acrogenous, 3- to 6-euseptate, 35–67 × 5–7 μm (rostrum included), brown and pale brown to subhyaline towards the apex, smooth-walled, with verruculose basal cell; rostrum 30–50 × 1.5–2.0 μm. Teleomorph unknown. **Matrix**: on decaying leaves of unidentified plant, in a rainforest Chajul, Chiapas, Mexico, leg. R. Guevara, 10. VI. 1999 (**Holotype**- XAL 803-3, Instituto de Ecología, Xalapa, Veracruz, México).

COMMENTS: The genus *Solicorynespora* (Figs 5–6) comprises seven accepted species: *S. aterrima* (Berk. & M.A. Curtis) R.F. Castañeda & W.B. Kendr. 1990, *S. calophylli* (Hol.-Jech. & R.F. Castañeda) R.F. Castañeda & W.B. Kendr.1990, *S. kendrickii* R.F. Castañeda 1996, *S. litchii* (Matsush.) R.F. Castañeda & W.B. Kendr. 1990, *S. obclavata* (Dyko & B. Sutton) R.F. Castañeda & W.B. Kendr. 1990, *S. pseudolmediae* (R.F. Castañeda) R.F. Castañeda & W.B. Kendr.1990, and the type species, *S. zapatensis* R.F. Castañeda & W.B. Kendr. 1990, but only *S. aterrima*, *S. calophylli*, *S. litchii* and *S. obclavata* superficially resemble *S. sylvatica* in their rostrate conidial morphology. Of them, the first has obclavate, conico-truncate, rostrate, 3- to 5-septate conidia, 33–74 × 8–10 μm, with verrucose, dark brown lower cells and pale brown, smooth upper cells; *S. calophylli* has 2-septate conidia, each with a stout, shortly rostrate, 3–6.5 × 2–3 μm, hyaline to subhyaline apical cell; *S. litchii* has conidia 3- (to 4-) septate, each with a subulate-rostrate, 7–17 × 1.5–2.0 μm, hyaline to subhyaline apical cell and another rostrate hyaline to subhyaline, 9–15 × 1.5 μm, lateral, subapical cell (appendix) directed downwards. *S. obclavata* has 4- to 6-euseptate, smooth conidia, 32.0–62.5 × 9.5–11.0 μm, with the upper two cells subhyaline to pale brown and the lower 3–4 cells brown. *Solicorynespora sylvatica* is therefore clearly distinct from these species.

Corynespora mulanjeensis B. Sutton 1993 has solitary, euseptate conidia which arise from an apical pore, making it more closely related to the genus *Solicorynespora*. The following new combination is therefore proposed:

Solicorynespora mulanjeensis (B. Sutton) R.F. Castañeda, M. Stadler et Guarro, comb. nov. FIGURE 6d

BASIONYM: *Corynespora mulanjeensis* B. Sutton, Mycological Papers **167**: 23 (1993).

Key to *Solicorynespora* species

1 *Conidia neither rostrate nor strongly tapered towards the apex* *2*

Conidia rostrate or strongly tapered towards the apex *3*

2 (1) *Conidia cylindrical to ellipsoid, 2- to 4-euseptate, 15–26 × 6–7 µm, smooth-walled, sometimes slightly verruculose, with brown central cells and subhyaline ends* .... **kendrickii**

Conidia obclavate to oval (2- to) 4- (to 5-) euseptate, 16–29 × 8.5–12.0 µm, smooth-walled, brown, each with a subhyaline to pale brown apical cell .... **pseudolmediae**

3 (1) *Conidia smooth-walled* *4*

Conidia verruculose or verrucose *5*

4 (3) *Conidia obclavate, rostrate towards the apex, 4- to 6-euseptate, 32.0–62.5 × 9.5–11.0 µm (rostrum included), smooth-walled, with lower cells medium brown and two upper cells subhyaline to pale* .... **obclavata**

Conidia obclavate to fusiform, gradually tapered to an obtuse apex, 5- to 8-euseptate, 56–71 × 10.0–12.5 µm, medium brown with the lower 4–5 cells slightly darker and dark brown at the base.................................... **mulanjeensis**

5 (3) *Conidia with no more than 4 septa* *6*

Conidia sometimes with more than 4 septa *7*

6 (5) *Conidia obpyriform to obclavate, 2-euseptate, 11–16 × 5.0–7.0 µm, brown; with a subhyaline to subhyaline, 3.0–6.5 × 2–3 µm, stoutly and shortly rostrate at apical cell* .... **calophylli**

Conidia obclavate, 3- (to 4-) euseptate, 21–32 × 6.5–8.5 µm, brown with a rostrate-subulate, apically elongated, 7–17 × 1.5–2.0 µm, hyaline or subhyaline apical cell and very often with a lateral, subulate, 9–15 × 1.5 µm, hyaline to subhyaline appendage .... **litchii**

7 (5) *Conidia 3- to 5-euseptate, obclavate, rostrate towards the apex, 33–74 ×8–10 µm, with dark brown lower cells and pale brown apical and subapical cells* .... **aterrima**

Conidia 3- to 6-euseptate, obpyriform to obclavate, very longrostrate, 35–67 ×5–7 µm (rostrum ncluded), brown and pale brown to subhyaline towards the apex. .... **sylvatica**

Figs 3-4. *Solicorynespora sylvatica*. Conidiophores, conidiogenous cells and conidia. **Fig. 3**. Drawings. **Fig. 4**: Micrographs. Bar = 10 µm.

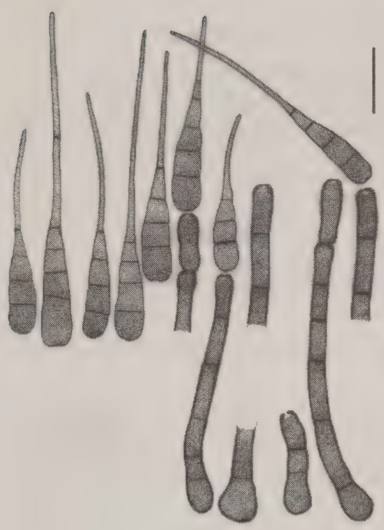

Fig. 3

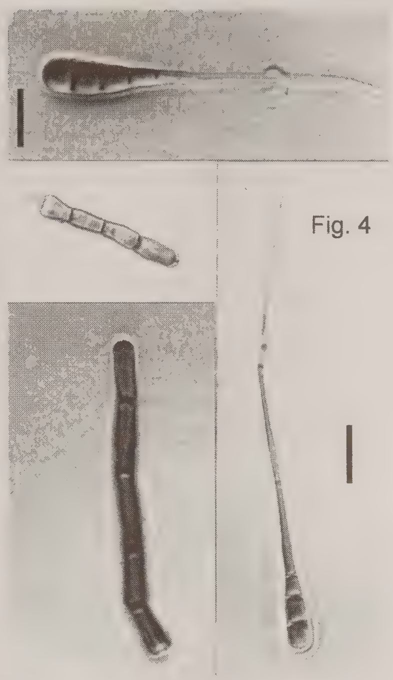

Fig. 4

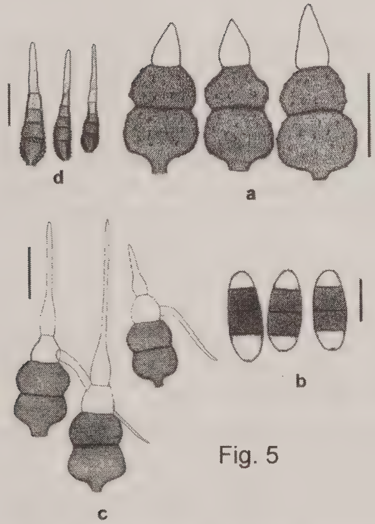

Fig. 5

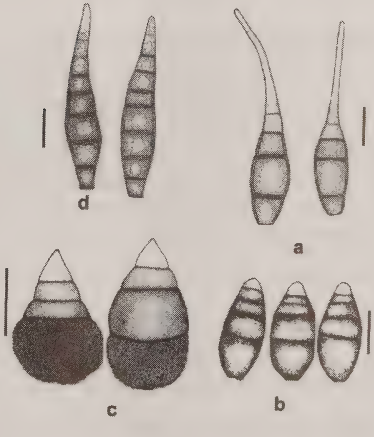

Fig. 6

Figs 5-6. Representative conidia of *Solicorynespora* spp. **Fig. 5a**.: *S. calophylli*. **Fig. 5b**: *S. kendrickii*. **Fig. 5c**: *S. litchii*. **Fig. 5d**. S. aterrima. - **Fig. 6a**:. *S. obclavata*. **Fig. 6b**: *S. pseudolmediae*. **Fig. 6c**: *S. zapatensis*. **Fig. 6d**: *S. mulanjeensis*. Bars = 10 μm.

Briansuttonia R.F. Castañeda, Minter et Saikawa, anam. gen. nov.

Ad fungos conidiales, hyphomycetes pertinens. ***Coloniae*** *effusae, pilosae usque funiculosae, brunneae vel atrobrunnea. Mycelium superficiale et aliquot in substrato immersum, ex hyphis septatis, anastomosantibus, brunneis vel atrobrunneis, laevibus vel verrucosis compositum.* ***Conidiophora*** *conspicua, mononemata, septata, erecta, brunnea vel atrobrunnea, laevia vel verrucosa.* ***Cellulae conidiogenae*** *uniloculosae, treticae, terminales, determinatae vel indeterminatae, proliferationibus percurrentibus enteroblasticis praeditae.* ***Loci conidiogeni*** *pori apicales.* ***Secedentia conidiorum*** *schyzolytica.* ***Conidia*** *solitaria, brunnea vel atrobrunnea, acrogena, sicca, obclavata, obpyriformia, ellipsoidea vel irregularia, truncata ad basim, laevia vel verrucosa, ex 2- ad 15-distoseptis transversis et pluribus distoseptis longitudinalibus et obliquis praedita.* ***Teleomorphosis*** *ignota.* ***Species typica*****:** ***Briansuttonia alternarioides*** (B. Sutton & Pascoe), comb. nov.

Etymology: In honour of Dr Brian C. Sutton (United Kingdom) in recognition of his contributions to the study of anamorphic fungi.

Conidial fungi, Hyphomycetes. **Colonies** effuse, hairy to funiculose, brown to dark brown. Mycelium superficial and rather immersed, composed of septate, anastomosing, brown or dark brown, smooth-walled or verrucose hyphae. **Conidiophores** differentiated, mononematous, septate, erect, brown to dark brown, smooth-walled or verrucose. **Conidiogenous cells** unilocal, tretic, terminal, determinate or indeterminate with enteroblastic percurrent proliferations. **Conidiogenous loci** an apical pore. **Conidial secession** schyzolytic. **Conidia** solitary, brown to dark brown, acrogenous, dry, obclavate, obpyriform, ellipsoid or irregular, truncated at the base, smooth-walled or verrucose, with 2- to 15-transverse distosepta and several longitudinal and oblique distosepta. Teleomorph: unknown. **Type Species**: *Briansuttonia alternarioides* comb. nov.

COMMENTS: When Sutton & Pascoe (1988) described *Corynespora alternarioides*, they remarked that, although the conidiophores and tretic conidium ontogeny resemble those of other *Corynespora* species, the resulting conidia are quite different: "no species hitherto described in *Corynespora* has conidia with transverse, longitudinal and oblique distosepta". If species with distoseptate, muriform conidia were to be included in this genus the generic concept would have to be expanded drastically. The differences noted by Sutton & Pascoe (1988) therefore provide good reasons to regard this taxon as different at generic level.

The genera *Alternaria* Nees (Ellis 1971, 1976) and *Stemphylium* Wallr. (Ellis 1971, 1976) resemble the new genus in having unilocal, apical conidiogenous loci and muriform conidia, but the conidiogenous loci in *Alternaria* are flat and melanized, and the conidia are euseptate. In *Stemphylium* the conidial ontogeny is holoblastic and that genus is also clearly distinguished by its euseptate muriform conidia.

Briansuttonia alternarioides (B. Sutton & Pascoe) R.F. Castañeda, Minter & Saikawa, comb. nov.

Basionym: *Corynespora alternarioides* B. Sutton & Pascoe, *Australian Systematic Botany* **1:** 127 (1988).

Acknowledgments

We are deeply indebted to Profs. Lori M. Carris (Washington State University) and Roger Goos (University of Rhode Island) for kindly reviewing the manuscript and for many suggestions that greatly improved it. We thank the Cuban Ministry of Agriculture and CITMA for facilities through projects 2053, 2053 and 2054, and the UK Darwin Initiative for financial support through the project "*Biodiversity Conservation in Cuba*". We also acknowledge the technical assistance of M. Caraballo.

Literature Cited

Castañeda Ruiz RF. 1996. New species of *Haplotrichum* and *Solicorynespora* from Cuba. Mycotaxon 59: 449-452.

Castañeda Ruiz RF, Kendrick WB. 1990. Conidial fungi from Cuba. II. University of Waterloo Biology Series 33: 1-61.

Ellis MB. 1971. Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, 608 pp.

Ellis MB. 1976. More Dematiaceous Hyphomycetes. Commonwealth Mycological Institute, Kew, 507 pp.

Guo YL. 1984. Four new species of *Corynespora*. Acta Mycologica Sinica 3: 161-169.

Kirk PM. (1982). New or interesting microfungi. VI. *Sporidesmiella* gen. nov. Transactions of the British Mycological Society 79: 479-489.

Morgan-Jones G. 1988. Notes on hyphomycetes. LX. *Corynespora matuszakii*, an undescribed species with narrow, cylindrical, catenate conidia and highly-reduced conidial lumina. Mycotaxon 33: 483-487.

Saikia UN, Sarboy AK. 1980. Hyphomycetes of North-East India II. Indian Phytopathology 33: *466-470*.

Siboe GM, Kirk PM. 1999. New dematiaceous hyphomycetes from Kenyan rare plants. Mycotaxon 73: 283-302.

Subramanian CV (1992). A reassessment of *Sporidesmium* (Hyphomycetes) and some related taxa. Proceedings of the Indian National Science Academy B58: 179-190.

Sutton BC 1993. Mitosporic fungi from Malawi. Mycological Papers 167: 1-93.

Sutton BC, Pascoe IG. 1988. Some dematiaceous hyphomycetes from branches and phyllodes of *Acacia* in Australia. Australian Systematic Botany 1: 127-138.

Wei CT. 1950. Notes on *Corynespora*. Mycological Papers 34: 1-10.

Yen JM. 1980. Etude sur les champignons parasites du sud-est asiatique. 37. Champignons parasites de Malaisie. 20. Bulletin Trimestriel de la Société Mycologique de France 96: 17-25.

Yen JM, Lim G. 1980. Etude sur les champignons parasites du sud-est asiatique. 39. Les *Corynespora* de Malaisie. Cryptogamie Mycologie 1: 83-90.

MYCOTAXON

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Two new species and a new record of *Anthracoidea (Ustilaginales)* from China

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Abstract—Two new species, *Anthracoidea kanasensis* on *Carex ovalis* and *A. striata* on *C. pediformis* are described. A new species for China, *A. rupestris* on *C. pediformis* is reported.

Keywords—Ustilaginomycetes, taxonomy, smut fungi

A smut fungus on *Carex ovalis*, a new record of plant for China, in the section *Planatae* of the subgenus *Vignea*, was collected from the Kanas Lake of Xinjiang Uygur Autonomous Region, in the Northwestern part of China. According to Prof. Liang Songjun's identification, the host plant is very closely related to *Carex maackii* Maxim. Until now no *Anthracoidea* has been reported from the section *Planatae*. Kükenthal (1909) put *Carex ovalis* in the section *Ovales* of the subgenus *Vignea*. On species of *Carex* in the subgenus *Vignea*, section *Ovales* two species of *Anthracoidea* have been recognized: 1) *Anthracoidea uleiana* (Syd. & P. Syd) Vánky (1997) [syn. *A. pannucea* (Liro) Vánky (1985)], with ustilospores measuring 14-17 μm in diameter, and "dark-brown spores with 3-5 light, thin-walled, rounded areas, which when the spores are dried collapse and form mamillate depressions, giving a peculiar aspect to the spores" (Vánky 1987); type on *Carex bonplandii* Kunth, Brazil, and 2) *Anthracoidea verrucosa* (Savile) Nannf., with ustilospores measuring 14-23 x 13-17 μm, wall 1 μm, evenly thickened; type on *Carex ebenea* Rydb., USA.

The fungus on *Carex ovalis* in China is similar to *Anthracoidea verrucosa* from which it differs mainly in having unevenly thickened ustilospore walls. It is described as:

Anthracoidea kanasensis H. C. Zhang & L. Guo, sp. nov. Figs. 1-2

Sori in ovariis, subglobosi, 1.5-2 mm longi, 1-1.5 mm lati, primo membrane cinerascenti, fungali cooperti, deinde expositi. Massa sporarum nigra, semiagglutinata. Ustilosporae a fronte subglobosae, ellipsoideae, ovoideae vel irregulares, (10.5-)15-22.5(-25) x (10.5-)11-20 μm, ab acie 9-12.5 μm latae, rubrobrunneae; pariete inaequaliter incrassato, 1-3 μm crasso, in angulis

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crassissimo, nonnunquam protuberantiis 1-4, gibberis internis 1-4 et areis refractivis 1-2, superficie dense verruculoso.

Sori in ovaries, subglobose, 1.5-2 mm long, 1-1.5 mm wide, at first covered by a grayish, fungal membrane, later becoming exposed. Spore mass black, semi-agglutinated. Ustilospores in plan view subglobose, ellipsoidal, ovoid or irregular, (10.5-)15-22.5(-25) x (10.5-)11-20 μm, in side view 9-12.5 μm wide, reddish-brown; wall unevenly thickened, 1-3 μm, thickest at the angles, sometimes protuberances 1-4, internal swellings 1-4, light reflective areas 1-2, surface densely verruculose, the warts often confluent.

On *Carex ovalis* Good. (Cyperaceae), Xinjiang: Burqin, Kanas Lake, alt. 1400 m, 8 VIII 2003, L. Guo & H. C. Zhang 2182, HMAS 86708 (holotypus); Burqin, Kanas Lake, alt. 1700 m, 8 VIII 2003, L. Guo & H. C. Zhang 2180, HMAS 86709 (paratypus).

There is a species of *Anthracoidea* on *Carex pediformis* in the subgenus *Carex*, section *Digitatae*, which is closely related to *Anthracoidea irregularis* (Liro) Boidol & Poelt. However it differs from *A. irregularis* in having larger ustilospores and stiate walls. It is described as:

Anthracoidea striata H. C. Zhang & L. Guo, sp. nov. Figs. 3-4

Sori in ovariis, subglobosi, 1.5-2.5 mm longi, 1.5-2.2 mm lati, primo membrane cinerascenti, fungali cooperti, deinde expositi. Massa sporarum nigra, semiagglutinata. Ustilosporae a fronte subglobosae, ellipsoideae, ovoideae vel irregulares, 15-30(-37.5) x 14-20 μm, ab acie 10-13 μm latae, rubrobrunneae vel flavidobrunneae; pariete inaequaliter incrassato, 1-3.5 μm crasso, in angulis crassissimo, protuberantiis 1-7, gibberis internis 1-5 et areis refractivis 1-3, superficie dense verruculoso, sub SEM verrucoso et striato.

Sori in ovaries, subglobose, 1.5-2.5 mm long, 1.5-2.2 mm wide, at first covered by a grayish, fungal membrane, later becoming exposed. Spore mass black, semi-agglutinated. Ustilospores in plan view subglobose, ellipsoidal, ovoid or irregular, 15-30(-37.5) x 14-20 μm, in side view 10-13 μm wide, reddish-brown or yellowish-brown; wall unevenly thickened, 1-3.5 μm, thickest at the angles, protuberances 1-7, internal swellings 1-5, light reflective areas 1-3, surface densely verruculose, the warts often confluent, in SEM prominently verrucose and partly striate.

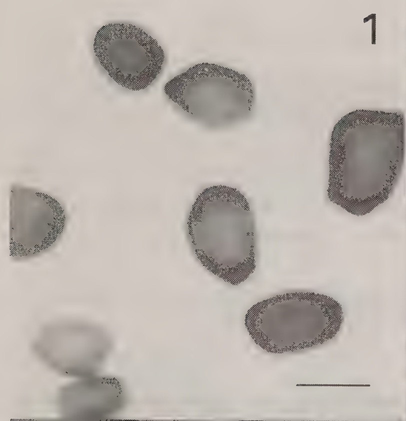
On *Carex pediformis* C.A. Mey (Cyperaceae), Xinjiang: Burqin, Hemuxiang, alt. 1100 m, 6 VIII 2003, L. Guo & H. C. Zhang 2153, HMAS 86710 (holotypus).

On *Carex pediformis* in the subgenus *Carex*, section *Digitatae*, a further species of *Anthracoidea* was collected in the Xinjiang Region. It is identified as *A. rupestris*, which is new to China (Guo 2000, 2002, 2004; Wang & Piepenbring 2002):

Figs. 1-2. Ustilospores of *Anthracoidea kanasensis* on *Carex ovalis* in LM and SEM (HMAS 86708, holotypus).

Figs. 3-4. Ustilospores of *Anthracoidea striata* on *Carex pediformis* in LM and SEM (HMAS 86710 holotypus).

Figs. 5-6. Ustilospores of *Anthracoidea rupestris* on *Carex pediformis* in LM and SEM (HMAS 86711). Bars = 11 μm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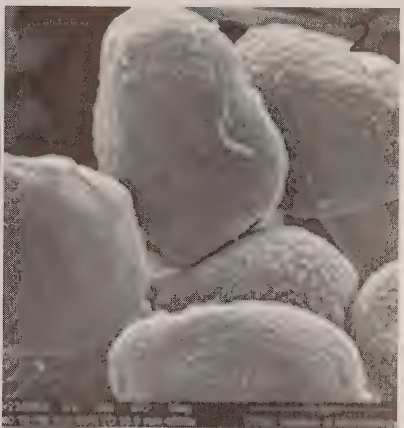
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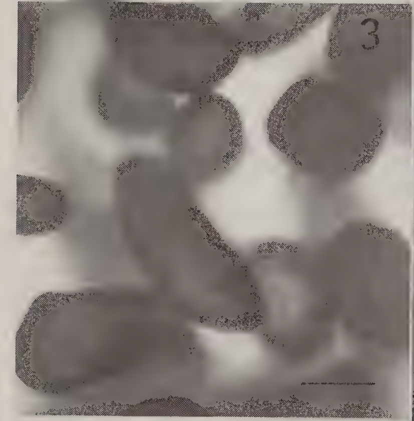
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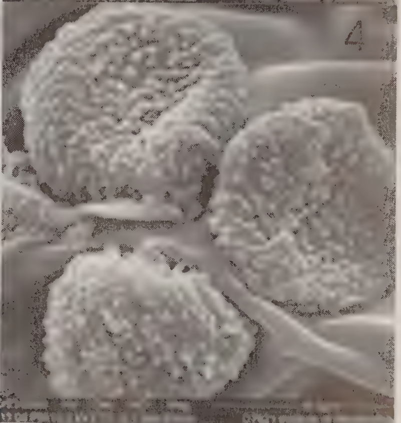
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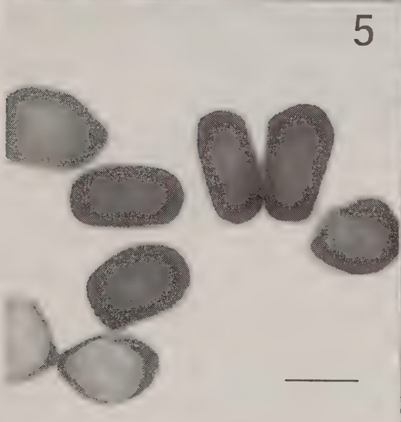
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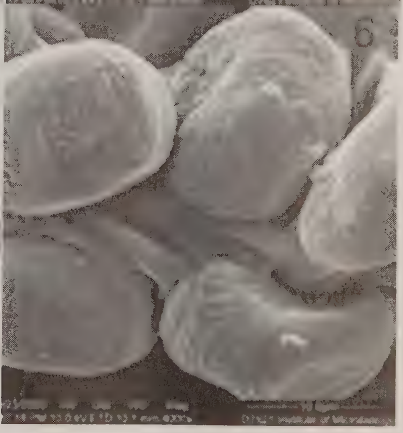
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Anthracoidea rupestris Kukkonen

Ann. Bot. Soc. Zool.-Bot. Fenn. „Vanamo“ 34(3):47, 1963. Figs. 5-6

Sori in ovaries, subglobose, 2.2-3.5 mm long, 2-3 mm wide, at first covered by a grayish membrane. Spore mass semi-agglutinated, black. Ustilospores in plan view subglobose, ellipsoidal, ovoid or irregular, 15-25.5(-30.5) x 14.5-22.5 µm, in side view 8-14 µm wide, reddish-brown or yellowish-brown; wall unevenly thickened, 1-3(-4) µm, thickest at the angles, protuberances 1-4, with light reflective areas, internal swellings commen, densely verruculose, the warts low, often confluent.

On *Carex pediformis* C. A. Mey, Xinjiang: Burqin, Kanas Lake, alt. 1500 m, 8 VIII 2003, L. Guo & H. C. Zhang 2181, HMAS 86711; Burqin, Kanas Lake, alt. 1800 m, 8 VIII 2003, L. Guo & H. C. Zhang 2175, HMAS 86712.

So far 22 species of *Anthracoidea* have been recorded for China, including *A. kanasensis*, *A. striata*, and *A. rupestris*.

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Literature Cited

Guo L. 2000. Flora Fungorum Sinicorum, *Ustilaginaceae* Vol. 12, - Science Press, Beijing. 124 pp.

Guo L. 2002. Two new species of Ustilaginomycetes and a species new to China.- Mycotaxon 82: 147-150.

Guo L. 2004. *Anthracoidea shaanxiensis* sp. nov. *(Ustilaginales)* from China. - Nova Hedwigia (in the press).

Kükenthal G. 1909. *Cyperaceae-Caricoideae*. - Das Pflanzenreich IV. 20, Leipzig. 824 pp.

Vánky K. 1985. Carpathian Ustilaginales. - Symb Bot Upsal 24(2): 1-309.

Vánky K. 1987. Illustrated Genera of Smut Fungi. - (ed. Jülich) Gustav Fischer Verlag, Stuttgart, New York. Crytogamic Studies 1: 1-159.

Vánky K. 1997. Taxonomical studies on *Ustilaginales*. XV. - Mycotaxon 62: 127-150.

Wang SR, Piepenbring M. 2002. New species and new records of smut fungi from China. - Mycol. Progress 1: 399-408.

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A revision of the types of *Diderma subcaeruleum* and *D. globosum* var. *europaeum*

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Abstract—The types of *Diderma alpinum*, *D. globosum* var. *europaeum*, *D. niveum* and *D. subcaeruleum* were compared by applying electron microscopy techniques. *Diderma subcaeruleum* was synonymized with *D. niveum* and *D. globosum* var. *europaeum* was synonymized with *D. alpinum*.

Key words—Myxomycetes, *Physarales,* SEM, taxonomy

Introduction

Meylan was the first author who studied exhaustively the nivicolous myxomycetes and who proposed a large number of new taxa for science. Altogether he proposed 14 species, 18 varieties and 13 forms. Unfortunately, he did not cite type material, as this was not mandatory at the time. It was Kowalski, who made an extensive revision of Meylan's material and lectotypified the abundant material stored in the herbarium LAU (Kowalski 1975).

In 2002 we began studying Meylan's type material, putting special emphasis on the genera *Lamproderma* and *Diderma*. Within the so-called *D. niveum* complex (Moreno et al. 2003c), consisting of nivicolous species of *Diderma* with sessile, white sporocarps and coriaceous peridia, the following type material of Meylan's species was studied: *Diderma alpinum, D. alpinum* var. *macrosporum, D. microcarpum* and *D. niveum* var. *ferrugineum.* Fortunately, we were also able to find and to study *D. niveum* proposed by Rostafinski. We have been able to synonymize *D. niveum* with *D. niveum* var. *ferrugineum* and we have proposed a new species, *D. meyerae.* However, we have not included the variety *D. globosum* var. *europaeum* proposed by Buyck (1988) in our study, that also can be included within the *D. niveum* complex, as the type was not available to us at that time. We have since been able to study the type material proposed by Buyck and to compare it with the *Diderma* already studied by us.

At the same time, we are studying the type material of the nivicolous species of myxomycetes proposed by Kowalski, who described 15 nivicolous species as new between the years 1966 and 1975. Among these, there are some very common species, such as *Lamproderma maculatum* and *Lepidoderma aggregatum*, but also rare species that have not been collected since and are known only from his collections, such as *Diderma subcaeruleum*, *D. nigrum*, or from a single collection, *Diacheopsis spinosifila* and *Trichia synspora*. In our recent studies, we have been able to demonstrate that various species are synonyms of other, more common species. Thus, we have proposed the synonymy of *Trichia synspora* with *T. varia* (Singer et al. 2003), *Diderma nigrum* with *D. asteroides* (Moreno et al. 2003b) and *Diacheopsis spinosifila* with *Lepidoderma didermoides* (Moreno et al. 2003a).

This shows how important it is to revise the type material of the nivicolous myxomycetes, in order to specify accurately the macroscopic and microscopic characteristics of the species described from this particular habitat.

Materials and Methods

The material was studied with a binocular microscope and, after mounting in Hoyer's medium, with a Nikon (Optiphot) microscope. Scanning electron microscopy (SEM) micrographs were taken in the University of Alcalá de Henares, using a Zeiss DSM-950. SEM-preparation was made as indicated in Moreno et al. (2002).

The type material comes from the herbaria BPI and NY and was compared with the material indicated in Moreno et al. (2003c).

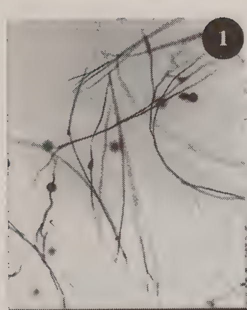
Diderma subcaeruleum Kowalski, *Mycologia* 60(3): 598. 1968

Figs 1-5

Original diagnosis: *Sporangiis gregariis, sessilibus, haemisphaericis vel paulo elongatis, chalybeis, 1-2 mm diam; peridio simplici, tenui, fragili, parce et innate calcareo; hypothallo inconspicuo; columella nulla vel, quandocumque presenti, exigua, alba; capillitio copioso, e filamentis gracilibus, rigidis, atropurpureo-brunneis ad apicem incoloratis, aliquantum parce ramosis anastomosantibusque composito; sporis globosis, atrobrunneis, verrucosis, 10-12 (-16) µm diam; plasmodio ignoto.*

Material studied: On decaying plant debris, near garbage dump, 6400 ft, 7.VIII.1967, Crater Lake National Park, Oregon, BPI 815218 (type) and BPI 815212 (isotype).

Figs 1-5. *Diderma subcaeruleum* (type). 1-2. Capillitium. 3-4. Spores. 5. Detail of spore ornamentation. **Figs 6-9.** *Diderma niveum* (type). 6. Capillitium. 7-8. Spores. 9. Detail of spore ornamentation.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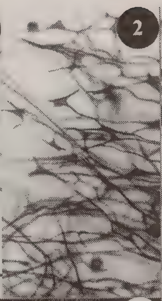
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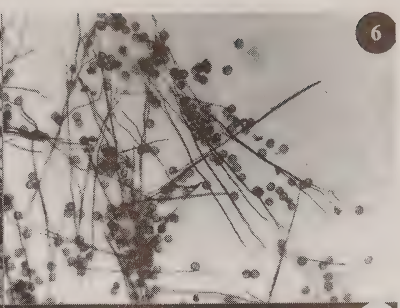
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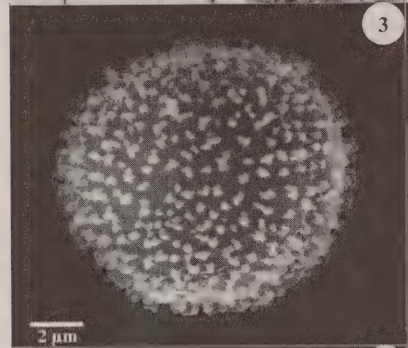
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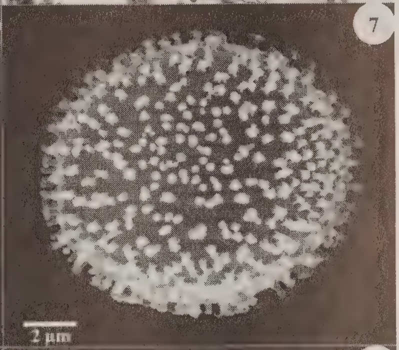
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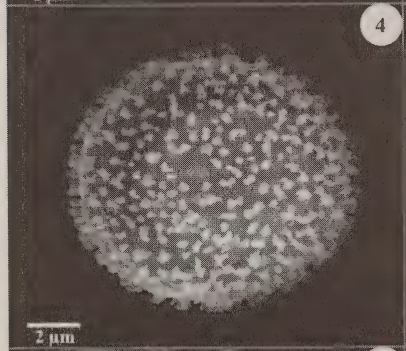
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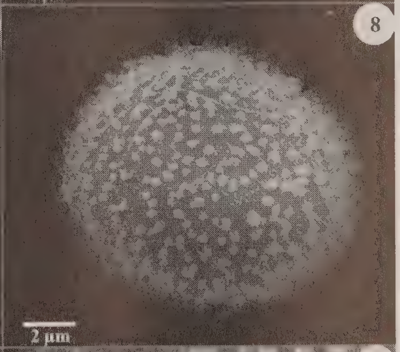
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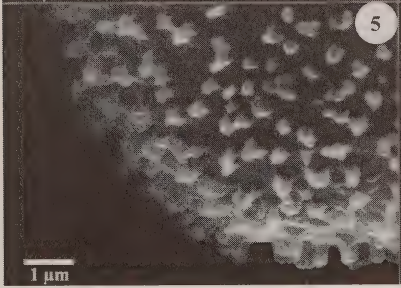
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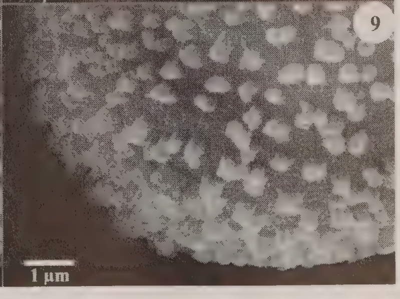
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The type material is kept in a box with Kowalski's personal herbarium number D.T.K. 6887 and the number BPI 815218. An isotype is kept in another box bearing the number BPI 815212. The type consists of four twigs with the bark still attached, covered by abundant well preserved sporocarps. The isotype presents one bark bearing twig with abundant fructifications arranged in three portions.

Sporophores sporocarpic to subplasmodiocarpic, 0.5-2.0 x 0.3-1 mm, aggregated, sessile, hemispheric to pulvinate, crushed laterally between them. Hypothallus translucent, generally inconspicuous. Stalk absent. Peridium double, persistent. Exoperidium calcareous, smooth to rugose, white to white with bluish discontinuous tones in the zones of sporocarps where this layer is badly formed, sometimes absent, in this case the endoperidium can be observed; irregular dehiscence. Endoperidium membranous, translucent, iridescent, closely united with the exoperidium. Columella sometimes absent, if present whitish to white with beige tones, very small to subglobose, up to 0.3 mm in diam. Capillitium (Figs 1-2) very dense, formed by straight, rigid filaments, 1-2 μm in diam., sometimes branched and anastomosed, with triangular to polygonal widened areas in the union of the threads, on the surface of the threads rarely appear globose nodules, filaments dark brown, paler towards the extremities with hyaline tips. Spores 10-12 μm in diam., spiny, violaceous brown in LM, dark brown in the mass. By SEM (Figs 3-5) the ornamentation is formed by baculae.

Diderma globosum* var. *europaeum Buyck, Bull. Jard. Bot. Belg. 58(1-2): 199. 1988

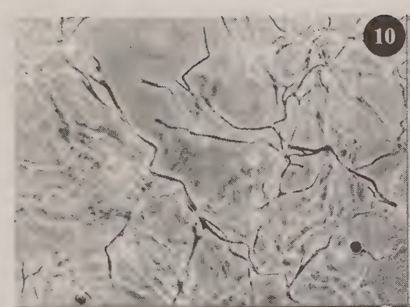
Figs 10-13

Original diagnosis: *A var. globoso recedens plasmodiocystis vel sporocystis irregularibus, columella depressa et fere convexa, capillitio firmo, sporis subglobosis, (10.07) 10.41-11.57 (12.30) µm diam (75 S, 3 C), lucem orientem versus visae egaliter coloratis.*

Material studied: Switzerland, on herbs and twigs, 2.V.1914, *leg.* Jaap, BPI 814106 (holotype) and NY 7830 (isotype).

The type is kept in a matchbox, in which two dry stems are stuck, where strongly aggregated fructifications can be observed, lacking almost completely peridium, capillitium and spores, but showing a columella taking up almost the whole base. In the sides of the sporocarps residues of the peridium remain.

Figs 10-13. *Diderma globosum* var. *europaeum* (type). 10. Capillitium. 11-12. Spores. 13. Detail of spore ornamentation. **Figs 14-17.** *Diderma alpinum* (type). 14. Capillitium. 15-16. Spores. 17. Detail of spore ornamentation.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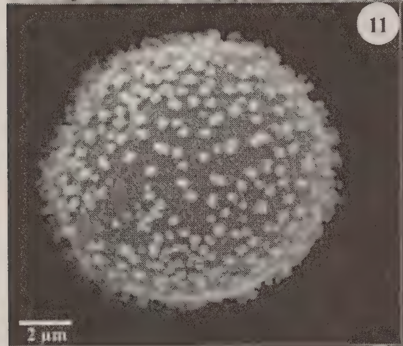
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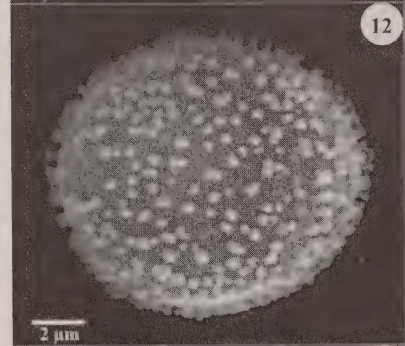
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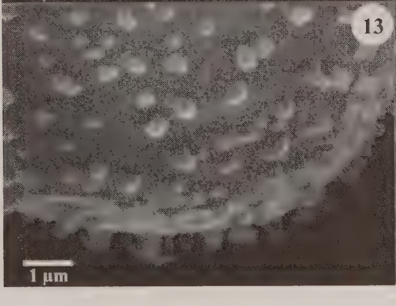
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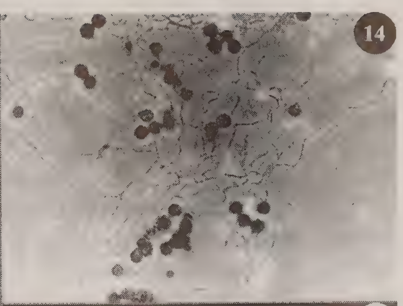
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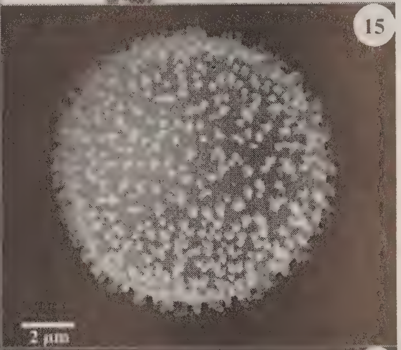
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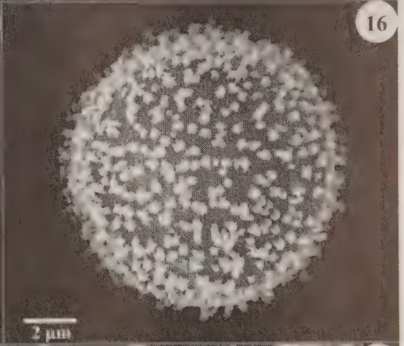
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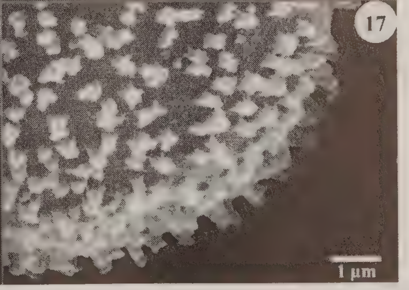
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The isotype is more abundant and consists of four pieces of dry stems stuck on the lid of a box, with abundant well preserved fructifications in three of them; one piece consists only of the bases of the sporotheca, as in the type material.

Sporophores sporocarpic, 1-1.5 mm in diam., to subplasmodiocarpic, 2-3 x 0.8-1.2 mm, some fructifications up to 6 mm long, aggregated, sessile, hemispheric to pulvinate. Hypothallus continuous, whitish, sometimes hardly conspicuous. Stalk absent. Peridium double, normally persistent. Exoperidium calcareous, smooth, white, with irregular dehiscence. Endoperidium membranous, translucent, iridescent, clearly separated from the exoperidium. Columella white, flat to broadly convex, covering almost the entire base of the sporotheca. Capillitium (Fig 10) formed by flexuouse filaments, about 1 μm in diam., rarely attaining 2 μm, branched and anastomosed, light violaceous brown, hyaline towards the extremities. Spores 11-12 μm in diam., spiny, violaceous brown in LM, dark brown in the mass. By SEM (Figs 11-13) the ornamentation is formed by baculae.

Discussion and Conclusions

According to Kowalski (1968) the outstanding characteristic of *Diderma subcaeruleum* is its blue-grey or steel-grey peridium, which is double, but due to the tight union of the thin, membranous, colourless inner layer with the outer layer, appears single. He was able to recognize this taxon in the field because of its colour, its crowded habit and its substrate, always being twigs.

He stresses the similarity with *Diderma niveum* because they both are alpine species having crowded sporocarps of the same diameter and identical spore size and ornamentation. As for differences between these two species he quotes the habitat, *D. niveum* preferring logs, *D. subcaeruleum* being found almost exclusively on decaying coniferous twigs, the colour of the sporocarps being usually white in *D. niveum* and greyish in *D. subcaeruleum*, the columella being large, globose or hemispherical, ochraceous to deep orange in *D. niveum* being a small, white or cream coloured mound at the base of the sporocarp, sometimes lacking in *D. subcaeruleum*, and finally the double peridium of *D. niveum* with its two layers distinctively separated.

Recently, we have made a study on several nivicolous taxa with white sporocarps (Moreno et al. 2003c) and synonymized *Diderma niveum* with *D. niveum* var. *ferrugineum*, proposing a hitherto undescribed species, *D. meyerae*, which was confused with the latter two taxa by early myxomycetologists. Thus, in order to understand Kowalski's observations, we have to know how he interpreted *D. niveum*, from which he separated *D. subcaeruleum* on the basis of the differences mentioned above. Kowalski (1975) distinguished the two species *D. niveum* and *D. alpinum*, considering

D. niveum var. *ferrugineum* a sporangiate form and thus a synonym of *D. alpinum*. He attributed a dark purple-brown capillitium to both *D. niveum* and *D. alpinum*, separating the latter species from *D. niveum* only by its usually plasmodiocarpous habit, or if sporocarpous, with sporocarps less than 1 mm in diam. Obviously, he misinterpreted *D. alpinum*, whose key character is its light-coloured, delicate capillitum, and not the growth habit that can be sporocarpous or plasmodiocarpous, regardless of its size. Thus, he did not know the *D. alpinum* of Meylan, which now can be studied in the new lectotype proposed by Moreno et al. (2003c). His concept of *D. niveum*, *D. niveum* var. *ferrugineum* and *D. alpinum* is, in our opinion, the same and corresponds to *D. niveum*.

We differ in our observations on *Diderma subcaeruleum*, a species that is known only from Kowalski's collections in California, in a few essential points from his original diagnosis and we cannot support his arguments that justify its separation from *D. niveum*. The exoperidium of *D. subcaeruleum* is white to white with bluish tones and is definitely lacking of a predominant greyish colouring, described by Kowalski as bluish grey, grey or steel-grey. Faint bluish tones can be observed in the areas of sporocarps where the exoperidium is badly developed and are due to inner layer showing through and producing this coloration. Furthermore, according to Kowalski, *D. subcaeruleum* prefers decaying coniferous twigs as its substrate, while *D. niveum* prefers logs. Certainly, it is true that some species of myxomycetes prefer a specific substrate, but as *D. subcaeruleum* was not collected again, we cannot be sure if this species was found exclusively on dead coniferous twigs or not. In the course of our studies we have also seen *D. niveum* on different types of substrates including decaying coniferous twigs. Also, we sometimes find a well developed columella in *D. subcaeruleum* which, according to Kowalski, is reduced to a mound at the base of the sporocarp: It should be kept in mind that the morphology of the columella in the nivicolous species of *Diderma* is highly variable. Finally, we consider the close union of the two peridial layers as not being a stable character, as this depends very much on environmental conditions. The spore diameters and spore ornamentation formed by baculae (Figs 3-5, 7-9) are the same in both species. Comparing the capillitium of the two types of *D. niveum* and *D. subcaeruleum* we observe a capillitium formed by straight and rigid threads with a few ramifications both in *D. niveum* and in *D. subcaeruleum* (Figs 1-2, 6), the latter taxon showing furthermore areas with a more dense ramification (Fig 2). As we have been able to study the variability of the species of the *D. niveum* complex (Moreno et al. 2003c), we agree with Neubert et al. (1995) in that the capillitium of *D. niveum* is very variable, and can even form a lax net.

All these reasons lead us to propose the synonymy of *Diderma subcaeruleum* with *D. niveum*.

Diderma globosum var. *europaeum* was described as new by Buyck (1988) after studying species of the *D. spumarioides-globosum* complex, characterized by its white, sessile fruitings seated on a well developed white, limey hypothallus: *Diderma cinereum*, *D. cingulatum*, *D. crustaceum*, *D. globosum* and *D. spumarioides*. Buyck observed differences between European and non-European species of *D. globosum*, the first ones - the new var. *europaeum* - having a capillitium similar to *D. cinereum*, with slender, flexuous threads, and the last one - the var. *globosum* - presenting capillitium features of *D. spumarioides*, i.e. having straight, more robust filaments.

Buyck considered *Diderma globosum* as a species preferring lower temperatures, and therefore relates it to *D. alpinum* and *D. niveum*, due to their same nivicolous preference. He distinguishes *D. globosum* from these two species by its white columella, somewhat smaller sporocarps and more intense iridescence of the peridial inner layer and according to him it shares with *D. niveum* spore features, having spores with one side distinctly darker by transmitted light, due to a better development of the spore wall.

According to Buyck (1982) *Diderma niveum* is not a strictly nivicolous species and has "spores densely and minutely warted, the warts often in lines so that in some specimens the spores appear subreticular." This is a key feature of *D. meyerae* that allows us to distinguish this species from *D. alpinum* and *D. niveum* (Moreno et al., 2003c). *Diderma meyerae*, however, is a strictly nivicolous species that cannot be found at lower elevations. The only thing we know for sure is that he misinterpreted *D. niveum*, which has a distinct type of episporal ornamentation.

Diderma globosum var. *europaeum* is, from our point of view, very similar to *D. alpinum*, mainly due to its flexuous, light violaceous brown to hyaline, rather slender capillitium (Fig 10) and its spores 11-12 μm in diam., with an ornamentation formed by baculae by SEM (Fig 13). The only difference is the presence of a flat and obtuse columella in *D. globosum* var. *europaeum* and a more prominent columella, subglobose to globose in the typical expression of *D. alpinum*. We consider the morphology of the sporocarps, columella and hypothallus neither constant nor reliable characters for the separation of the species of the *D. niveum* complex and think that only the spore ornamentation and the colour and morphology of the capillitium can be useful to do this (Moreno et al. 2003c). The perseverance in the examined material of the absence of the columella makes us consider it a form of *D. alpinum*, in order to facilitate its taxonomic framing.

Unfortunately, we could not study the *Diderma niveum* f. *endoleuca* described by Meylan (1924), as we have not been able to locate it in the herbarium LAU. This species is characterized by its snow-white inner peridial wall and columella. The presence of a well developed columella indicates a similarity with *D. niveum* or *D. meyerae*. Study of the capillitium and the spore ornamentation would be necessary in order to decide this and can be made only if material determined by Meylan as *D. niveum* f. *endoleuca* can be found.

Neubert et al. (1995) described *Diderma niveum* f. *endoleuca* furthermore as having short plasmodiocarps and a light brownish, delicate capillitium and believed that *D. globosum* var. *europaeum* matches well with Meylan's description of this form.

In conclusion, we recognize three species within the *Diderma niveum* complex: *Diderma meyerae*, *D. niveum* and *D. alpinum*.

Within the species *Diderma alpinum* we recognize the following forms:
1.- *Diderma alpinum* f. *alpinum* (Meyl.) Meyl., Bull. Soc. Vaud. Sci. Nat. 51: 261. 1917
2.- *Diderma alpinum* f. *macrosporum* (Meyl.) *comb. et stat. nov.*, Bull. Soc. Vaud. Sci. Nat. 58: 319. 1935
Basionym: *Diderma alpinum* var. *macrosporum* Meyl., Bull. Soc. Vaud. Sci. Nat. 58: 319. 1935
3.- *Diderma alpinum* f. *europaeum* (Buyck) *comb. et stat. nov.*
Basionym: *Diderma globosum* var. *europaeum* Buyck, Bull. Jard. Bot. Belg. 58(1-2): 199. 1988
4.- *Diderma alpinum* f. *microcarpum* (Meyl.) G. Moreno, H. Singer & Illana, Cryptog. Mycol. 24: 57. 2003

As it is also the case in other genera of nivicolous myxomycetes where specimens with large spore size are commonly collected, we could consider *Diderma alpinum* f. *macrosporum* to be included within the concept of *D. alpinum* by simply extending range of the spore size for this taxon.

Key of the *Diderma alpinum* complex

1. Sporocarps <1 mm in diam .... *D. alpinum* f. *microcarpum*
1'.Sporocarps >1 mm in diam. 2

2. Spores 15-17 μm in diam................................ *D. alpinum* f. *macrosporum*
2'. Spores 11-13 μm in diam. 3

3. Columella subglobose to globose .... *D. alpinum* f. *alpinum*
3'. Columella flat to broadly convex .... *D. alpinum* f. *europaeum*

Acknowledgements

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Literature cited

Buyck B. 1982. The genus *Diderma* Persoon (Myxomycetes) in Belgium. Bull. Jard. Bot. Belg. 52: 165-209.

Buyck B. 1988. The *Diderma spumarioides-globosum* complex (Myxomycetes). Bull. Jard. Bot. Belg. 58: 169-218.

Kowalski DT. 1968. Three new species of *Diderma*. Mycologia 60: 595-603.

Kowalski DT. 1975. The Myxomycete taxa described by Charles Meylan. Mycologia 67: 448-494.

Meylan C. 1924. Recherches sur les Myxomycètes du Jura en 1921-22-23. Bull. Soc. Vaud. Sc. Nat. 55: 237-244.

Moreno G, Singer H, Illana C. 2003a. *Diacheopsis spinosifila*, a synonym of *Lepidoderma didermoides*. Mycotaxon 88: 123-128.

Moreno G, Singer H, Illana C, Lizárraga M. 2003b. *Diderma nigrum*, a synonym of *Diderma asteroides* (Myxomycetes). Oesterr. Z. Pilzk. 12: 23-29.

Moreno G, Singer H, Illana C, Sánchez A. 2003c. Studies on nivicolous Myxomycetes. The *Diderma niveum* complex in Europe. Cryptog. Mycol. 24: 39-58.

Moreno G, Sánchez A, Singer H, Illana C, Castillo A. 2002. Fungi non delineati raro vel haud perspecte et explorate descripti aut definite picti. Pars XIX. A study on nivicolous Myxomycetes. The genus *Lamproderma* I. Edizioni Candusso.

Neubert H, Nowotny W, Baumann K, Marx H. 1995. Die Myxomyceten Deutschlands und des angrenzenden Alpenraumes unter besonderer Berücksichtigung Österreichs. Band 2. Physarales. Gomaringen. Karlheinz Baumann Verlag.

Singer H, Moreno G, Illana C, Lizárraga M. 2003. *Trichia synspora*, a synonym of *Trichia varia*. Mycotaxon 87: 243-248.

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Additional new species in the lichen family *Graphidaceae* (Lichenised Ascomycota) from the Solomon Islands

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Abstract—*Graphina maritima, Graphis alloafzelii, G. cristobalensis, G. discarpa, G. luluensis* and *Phaeographina celata* from the Solomon Islands are reported as new to science.

Introduction

In 1965 the Royal Society organised an expedition to study the natural history of the Solomon Islands and, *inter alia*, a large number of lichen specimens were collected. The results of the expedition were discussed at a meeting of the Society held in March 1968 and these were published in 1969 (Corner 1969) but no account of the lichens was included in this discussion.

The first lichen to be described from the 1965 collections was the new genus *Melanophloea* and the new species *M. pacifica* P. James & Vezda (James & Vezda 1971). Later, Stenroos (1986) identified *Cladonia didyma* (Fée) Vain., *C. macilenta* Hoffm. and *C. weymouthii* F. Wilson ex A.W. Archer among the specimens collected by Hill.

Subsequently a large number of species in the genera *Myeloconis, Porina, Pyrenula, Strigula, Tricothelium and Trypethelium* were reported by McCarthy (McCarthy 2002, 2003) based on specimens from the 1965 collections. New species in the genera *Graphina, Graphis* and *Phaeographina* have been described (Archer 2002, 2003a) and new species in the genus *Sclerophyton* were also reported (Archer 2003b).

Further examination of the specimens from the Solomon Islands showed the presence of six new species in the *Graphidaceae* which are described here.

The specimens examined were all collected by D.J. Hill between May and November 1965 and are now housed in BM. The locations of the collecting sites are shown in Corner (Corner 1969: 190, Fig. 1). Chemical constituents were identified by thin-layer chromatography (Culberson 1972) and, where necessary, their identity was confirmed by high-performance liquid chromatography (Elix *et al.* 2003).

Taxonomic Descriptions

Graphina maritima A.W. Archer, *sp. nov* **Figure 1**

Similis *Graphina pseudoanaloga* (Vain.) Zahlbr. sed acidum norsticticum deficiens differt.

Etymology: from the Latin *maritimus*, growing by the sea.

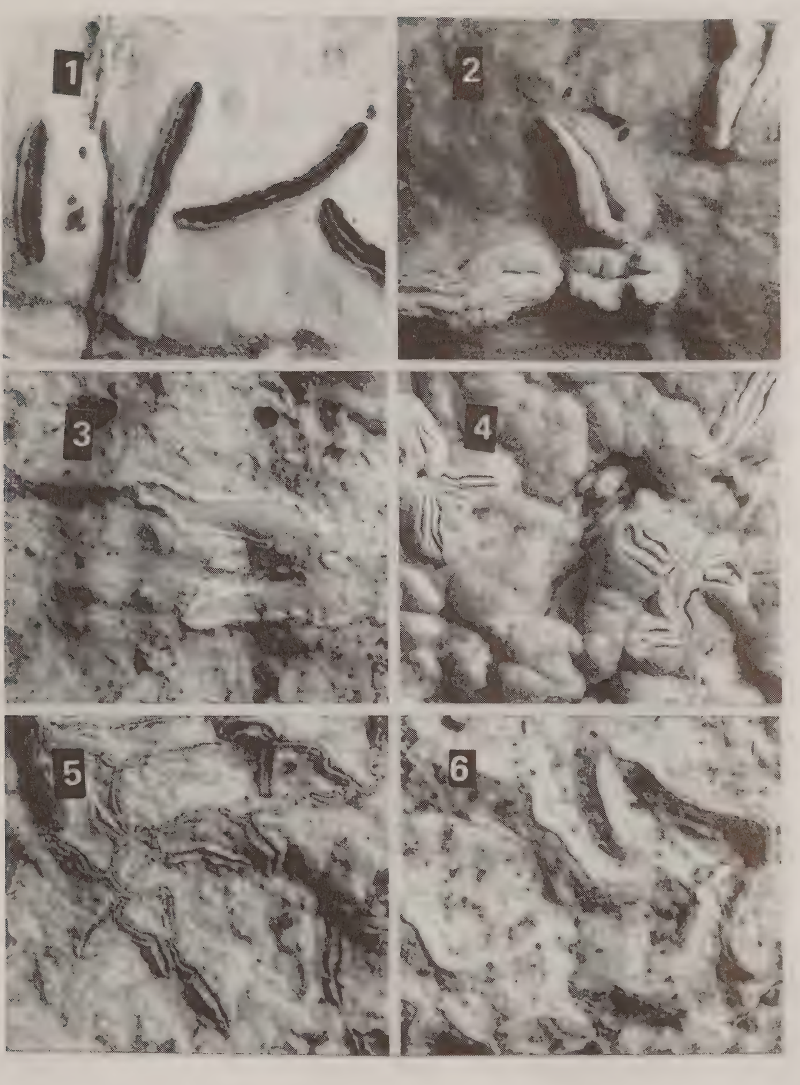
Type: **SOLOMON ISLANDS**. **Makira Province**. **San Cristobal Island**, Wainoni Region, between mouth of Huni River and headland along coast, ca. 1/2 mile [0.8 km] to the south, on trees along the beach, *D.J Hill 9821*, 15.viii.1965; holotype BM.

KEY CHARACTERS — Thallus off-white, thin, corticolous, surface smooth and dull. **Apothecia** lirelliform, conspicuous, black, numerous, scattered, simple, straight, curved or sinuous, sessile, 1–3 mm long, 0.15–0.3 mm wide, lips closed, with a conspicuous thalline margin, terminally acute. **Proper exciple** completely carbonised. **Hymenium** 100–120 µm tall, not inspersed, I-ve. **Ascospores** muriform, narrow ellipsoid, hyaline, 8 per ascus, 33–36 µm long, 10–12 µm wide, 8–10 x 2–4-locular, I+ blue.

Chemistry: no compounds found.

Ecology — *Graphina maritima* is a corticolous species found at sea-level on San Cristobal Island.

COMMENTS — *Graphina maritima* is characterised by black lirellae with a conspicuous thalline margin, the completely carbonised proper exciple and the absence of lichen compounds. The new species resemble *G. pseudoanaloga* (Vain.) Zahlbr. (Vainio 1915) from Guadeloupe but that species has an inspersed hymenium, terminally rounded lirellae [cf. Wirth & Hale 1978: 63, Plate 10a] and contains norstictic acid, in contrast to *G. maritima* which has a non-inspersed hymenium, terminally acute lirellae and lacks lichen compounds. *Graphina maritima* also resembles *G. sulcatula* Müll. Arg., but that species has sulcate lirellae and smaller ascospores. The species is so far known only from the type locality.



FIGURES 1–6. New species of Graphidaceae. **1**. *Graphina maritima*; **2**. *Graphis alloafzelii*; **3**. *G. cristobalensis*; **4**. *G. discarpa*; **5**. *G. luluensis*; **6**. *Phaeographina celata*.(Holotypes in BM). Magnification: 14x.

Graphis alloafzelii A.W. Archer, *sp. nov.* **Figure 2**

Similis *Graphis afzelii* Ach. sed acidum psoromicum continens vice acidum lecanoricum differt.

Etymology: from the Greek *allos*, other, and the species resemblance to *Graphis afzelii*.

Type: **SOLOMON ISLANDS**. **Western Province**. **Kolombangara Island**, south summit, montane moss forest, 5400 ft [1650 m], *D.J. Hill 10472*, 2.ix.1965; holotype: BM.

KEY CHARACTERS — **Thallus** thin, pale reddish brown, corticolous, surface smooth and shiny. **Apothecia** lirelliform, white, black where abraded, conspicuous, scattered, sessile, simple, straight, curved or sinuous, 1–3 mm long, 0.25–0.6 mm wide. **Proper exciple** laterally carbonised, covered by a white powdery layer. **Hymenium** 100–120 μm tall, not inspersed. **Ascospores** 8 per ascus, ellipsoid, hyaline, 18–20 μm long, 8–10 μm wide, 4-locular, I-ve.

Chemistry: lirellae: C-ve, Pd+ yellow; psoromic acid (major) and 2’-*O*-demethylpsoromic acid (minor).

Ecology: *Graphis alloafzelii* is a corticolous species found at 1650 m on Kolombangara Island.

COMMENTS — *Graphis alloafzelii* is characterised by simple white lirellae, 4-locular ascospores and the presence of psoromic acid. The new species closely resembles *G. afzelii* Ach., a widely distributed tropical to subtropical species which also occurs in the Solomon Islands [San Cristobal Island, at the mouth of the Huni River at sea level, *D.J. Hill 9019*, BM] but contains psoromic acid in place of the lecanoric acid found in *G. afzelii.* The lecanoric acid in *G, afzelii* is contained in the white outer coating of the lirellae as is the psoromic acid in *G. alloafzelii*. The new species is distinguished from the somewhat similar *Graphina hillii* A.W. Archer (Archer 2002) by the 4-locular ascospores, muriform in *G. hillii* and the chemistry; *G. hillii* contains subpsoromic acid. The new species is so far known only from the type locality.

Graphis cristobalensis A.W. Archer, *sp. nov.* **Figure 3**

Similis *Platythecium acutisporum* Staiger sed ascosporis apicibus rotundis vice acutis et excipulo pallido-badio differt.

Etymology: from the Latin *ensis*, place of origin, and the type locality, San Cristobal Island.

Type: **SOLOMON ISLANDS**. **Makira Province**. **San Cristobal Island**, N of Ugi Island, near Pawa School, ca. 1/2 mile [0.8 km] along path inland and into jungle, alt. *ca.* 50ft [15 m], *J.D. Hill 8706*, 12.viii.1965; holotype: BM.

KEY CHARACTERS — **Thallus** pale fawn, corticolous, surface smooth and shiny. **Apothecia** lirelliform, conspicuous, sessile in irregular clusters *ca.* 3 x 4 mm, individual lirellae 0.25–0.4 mm wide, with a conspicuous, raised, white thalline margin. **Epithecium** pale grey, fine white-pruinose. **Exciple** complete, thin, pale reddish brown, **Hymenium** 100–120 µm tall, pale brown, not inspersed, I-ve. **Ascospores** 8 per ascus, elongate-ellipsoid, hyaline, 13–16 µm long, 5–6 µm wide, 4-locular, I+ pale blue.

Chemistry — testacein.

Ecology — *Graphis cristobalensis* is an uncommon corticolous species found at sea-level at *ca.* 15 m elevation in secondary and disturbed primary rainforest on San Cristobal Island.

COMMENTS— *Graphis cristobalensis* is characterised by conspicuous, sessile, open lirellae, small 4-locular ascospores and the presence of testacein. This compound is uncommon in the Graphidaceae and is found in *Graphina allosporella* (Nyl.) Müll. Arg. (Nylander 1869), *G. sphaerosporella* (Nyl.) Müll. Arg. (Nylander 1869) and *Platythecium acutisporum* Staiger (Staiger 2002). The new species is distinguished from the two *Graphina* species by the 4-locular ascospores, and from the *Platythecium* species by terminally rounded ascospores. In addition, the exciple in *G. cristobalensis* is pale brown, in contrast to that of *P. acutisporum* which is carbonised. The new species is so far known only from two specimens, from the same locality, with the same collector's number.

Graphis discarpa A.W. Archer, *sp. nov.* **Figure 4**

Similis *Graphis descissa* Müll. Arg. sed lirellis interstinctis et ascosporis majoribus.

Etymology: from the Latin *dis*, separate, and the Greek *karpos*, fruit, a reference to the separated lirellae.

Type: **SOLOMON ISLANDS**. **Western Province**. **New Georgia Group**, Marovo Lagoon, Paleki Island, sea-level, *D.J. Hill 8400*, 3.viii.1965; holotype: BM.

KEY CHARACTERS —**Thallus** pale olive-green, corticolous, surface tuberculate and dull. **Apothecia** lirelliform, numerous, scattered, immersed, visible as a thin black line with white margins separated from the thallus, simple, straight, curved or sinuous, rarely branched, lips closed, 1–3 mm long, 0.15–0.3 mm wide. **Proper exciple** completely carbonised. **Hymenium** 160–180 µm tall, not inspersed, I-ve. **Ascospores** narrowly ellipsoid, hyaline, 8 per ascus, irregularly 2-seriate, 38–48 µm long, 8–10 µm wide, 8–11 locular, I+ blue.

Chemistry — stictic acid.

Ecology — *Graphis discarpa* is an uncommon corticolous species found on tree trunks at sea-level on Paleki Island, New Georgia Group.

COMMENTS — *Graphis discarpa* is characterised by lirellae immersed in, but separated from, the thallus, the completely carbonised exciple and the presence of stictic acid. The new species is distinguished from *G. descissa* Müll. Arg. (Müller 1895) by the sharply separated, immersed lirellae and the larger ascospores, 38-48 µm long in contrast to *G. descissa* which has subsessile lirellae and ascospores 28-38 µm long. *Graphis discarpa* somewhat resembles the chemically similar *G. bougainvillei* Zahlbr. (Zahlbruckner 1912) but that species has immersed lirellae, not separating from the thallus, the exposed exciple is slightly white-pruinose, and it has smaller ascospores, 30-35 µm long. The new species is differentiated from *G. immersella* Müll. Arg. (Müller 1895), which also occurs in the Solomon Islands, by the completely carbonised exciple, in contrast to it being laterally carbonised in *G. immersella*.

The new species is so far known only from two specimens (with the same collector's number) from the same locality.

Graphis luluensis A.W. Archer, *sp. nov.* **Figure 5**

Similis *Graphis centrifuga* Räs. sed ascosporis majoribus et acidum sticticum continens vice acidum norsticticum differt.

Etymology: from the Latin, *ensis*, place of origin, and Lulu Island, the type locality.

Type: **SOLOMON ISLANDS**. **Western Province**. **New Georgia Group**, Marovo Lagoon, west side of Lulu Island, sea-level, *D.J. Hill 8667*, 8.viii.1965; holotype: BM.

KEY CHARACTERS — **Thallus** pale fawn, thin, corticolous, surface smooth and shiny. **Apothecia** lirelliform, conspicuous, numerous, crowded, immersed, curved and sinuous, much-branched, lips closed, sometimes becoming open, 1.5–4 mm long, 0.1–0.2 mm wide. **Proper exciple** completely carbonised. **Hymenium** 100–120 µm tall, inspersed, I-ve;

Ascospores 8 per ascus, hyaline, 25–32 mm long, 6–7 µm wide, 6–8-locular, I+ blue.

Chemistry — stictic acid.

Ecology — *Graphis luluensis* is an uncommon corticolous species found at sea-level on Lulu Island, New Georgia Group.

COMMENTS— *Graphis luluensis* is characterised by the crowded, much branched lirellae, the completely carbonised exciple and the presence of stictic acid. The new species resembles the Australian species *Graphis centrifuga* Räs. (Räsänen 1949; Archer 1999: 288, Fig. 4a) but differs from that species in having larger ascospores and containing stictic acid. *Graphis luluensis* is distinguished from the chemically similar *G. descissa* Müll. Arg. (Müller 1895) and *G. dendrogramma* Nyl. (Nylander 1877) by the smaller ascospores and the completely carbonised exciple, respectively, and from *G. propinqua* Müll. Arg. (Müller 1882) by the presence of stictic acid. *Graphis luluensis* also resembles the chemically similar *G. modesta* Zahlbr. (Zahlbruckner 1912) from Bougaineville. Both species possess ascospores of a similar size [20–6 x 6–8 µm, 6–8-locular in *G. modesta*] but the exciple in *G. modesta* is laterally carbonised with open lips revealing a white-pruinose disc, in contrast to the completely carbonised exciple with closed lips of *G. luluensis*.

The new species is so far known only from the type locality from Lulu Island.

Phaeographina celata A.W. Archer, *sp. nov.* **Figure 6**

Similis *Phaeographina quassiicola* (Fée) Müll. Arg. sed lirellis semi-immersis, ascosporis minoribus et acidum norsticticum continens differt.

Etymology: from the Latin, *celatus*, hidden, a reference to the inconspicuous, semi-immersed lirellae.

Type: **SOLOMON ISLANDS**. **Makira Province**. **San Cristobal Island**, Wainoni Region, *ca.* 2 miles [3.2 km] SE of Wainoni Mission, alt. 1500–1600 ft [460–490 m], *D.J. Hill 8869*, 14.viii.1965; holotype: BM.

KEY CHARACTERS — **Thallus** of-white to pale fawn, thin, corticolous, surface smooth and shiny. **Apothecia** lirelliform, inconspicuous, concolorous with the thallus, semi-immersed scattered, curved or sinuous, sometimes branched, 2–5 mm long, 0.3–0.5 mm wide, lips closed. **Proper exciple** black, completely carbonized, thick, covered with a thin thalline coating. **Hymenium** 150–180 µm tall, not inspersed. **Ascospores** 8 per ascus, muriform, brown, narrowly ellipsoid, 40–48 μm long, 14–18 μm wide, 8–10 x 1–4-locular.

Chemistry: norstictic acid.

Ecology — *Phaeographina celata* is an uncommon corticolous species found on *Casuarina papuana* in disturbed primary rainforest at *ca.* 500 m on San Cristobal Island.

COMMENTS — *Phaeographina celata* is characterised by pale grey, inconspicuous lirellae, the thick black exciple, the pale brown, muriform ascospores and the presence of norstictic acid. The new species resembles *P. quassiicola* (Fée) Müll. Arg. in that both species have have brown, muriform ascospores and a complete carbonised exciple covered by a thin thalline layer. However, *P. celata* has smaller ascospores, 40–48 μm long, compared to those in in *P. quassiicola* which are 55–103 μm long (Staiger 2002: 449) and, in addition, contains norstictic acid; *P. quassiicola* lacks lichen compounds.

The new species is so far known only from the type locality on San Cristobal Island.

A CORRECTION

In a recent paper describing new *Graphidaceae* from the Solomon Islands (*Mycotaxon* **83**: 366 (2002) the holotype of *Phaeographina amnicola* was incorrectly reported to be Hill 8133; the correct specimen number is Hill 8132.

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Literature cited

Archer AW. 1999. The lichen genera *Graphis* and *Graphina (Graphidaceae)* in Australia 1. Species based on Australian type specimens. Telopea **8**: 273–295.

Archer AW. 2002. *Graphidaceae* (Ascomycotina) from the Solomon Islands: new species from Guadalcanal. Mycotaxon **83**: 361–367.

Archer AW. 2003a. New species in the lichen family *Graphidaceae* (Ascomycota) from Australia and the Solomon Islands. Mycotaxon **88**: 143–148.

Archer AW. 2003b. New species in the genus *Sclerophyton* (Ascomycota, *Opegraphaceae*) from Australia and the Solomon Islands. Mycotaxon **87**: 85–89.

Corner EHJ. 1969. A discussion on the results of the Royal Society Expedition to the British Solomon Islands Protectorate 1965. Philos. Trans., Ser. B, **255**: 185–631.

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardised thin-layer chromatographic method. J. Chromatogr. **72**: 113–125.

Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. Biblioth. Lichenol. **86**: 1–7.

James P, Vezda A. 1971. *Melanophloea* P. James & Vezda, a new lichen genus. Lichenologist **5**: 89–91.

McCarthy PM. 2002.Some corticolous and saxicolous pyrenolichens from the Solomon Islands. Australas. Lichenol. **51**: 40–43.

McCarthy PM. 2003. Foliicolous *Trichotheliaceae* from the Solomon Islands and Vanuatu. Australas. Lichenol. **52**: 20–24.

Müller J. 1882. Lichenologische Beiträge XVI. Flora **65**: 499–505.

Müller J. 1895. Sertum Australiense s. species novae australienses Thelotremearum, Graphidearum et Pyrenocarpearum. Bull. Herb. Boissier **3**: 315–327.

Nylander W. 1869. Lichenes in Brasilia a Glaziou collecti. Flora **52**: 117–126.

Nylander W. 1877. in Crombie JM, The lichens of the Challenger Expedition. J. Linn. Soc., Bot. 16: 211–231.

Räsänen V. 1949. Lichenes novi V. Ann. Bot. Fenn. **3**: 178–188.

Staiger B. 2002. Die Flecten familie *Graphidaceae*. Biblioth. Lichenol. **85**: 1–526.

Stenroos S. 1986. The family *Cladoniaceae* in Melanesia. 2. *Cladonia* section *Cocciferae*. Ann. Bot. Fenn. **23**: 239–250.

Vainio EA. 1915. Additamenta ad lichenographia Antillarum illustrandum. Ann. Acad. Sci. Fenn., Ser. A, 6,**7**: 1–226.

Wirth M, Hale ME 1978. Morden-Smithsonian Expedition to Dominica: The lichens (Graphidaceae). Smithsonian Contr. Bot. **40**: 1-64.

Zahlbruckner A. 1912. Flechten des Neuguinea-Archipels, der Hawaiischen Inseln und der Insel Ceylon. Denkschr. Kaiserl. Akad. Wiss. Math.-Naturwiss. Kl. **88**: 12–31.

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Hydropus kauffmanii, first records from Europe

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Abstract—*Mycena kauffmanii* is reported for the first time from Europe, where it has been collected under neutrophilic *Salix* spp. from two sites in the Northern French Alps and one on the French littoral of the Channel. The species is compared to the related *Hydropus floccipes*, and its ambiguous systematic position in the genus *Hydropus* is discussed. The European material is shown to be identical to North American collections, including the holotype. The new combination, *Hydropus kauffmanii*, is proposed.

Résumé—*Mycena kauffmanii* est signalé pour la première fois en Europe, à partir de récoltes effectuées dans deux localités des Alpes françaises septentrionales et une localité du littoral de la Manche, sous buissons de saules neutrophiles. Il est comparé à l'espèce voisine *Hydropus floccipes*, et sa position systématique ambiguë au sein du genre *Hydropus* est discutée. Le matériel original d'Amérique du Nord (y compris l'holotype) est identique au matériel européen. Une nouvelle combinaison est proposée: *Hydropus kauffmanii*.

Key-words—Agaricales, Basidiomycota, Tricholomataceae

Introduction

The genus *Hydropus* Kühner ex Singer, which occurs worldwide, is abundant in tropical areas (Singer 1982) but poorly represented in temperate areas. In Europe, about 15 taxa are recognized (Hausknecht *et al.* 1997; Contu & Robich 1998; Bas 1999; Esteve-Raventós et al. 2002). Most are rare and limited to individual ecological habitats: *H. marginellus* (Fr.: Fr.) Singer and *H. atramentosus* (Kalchbr.) Singer occur only on rotten *Abies* stumps, *H. subalpinus* (v. Höhn.) Singer on buried *Fagus* branches, *H. dryadicola* (Kühner) E. Horak in calcareous alpine meadows, *H. paradoxus* var. *xerophyticus* Esteve-Rav. *et al.* in xerophytic grasslands. Some recently described species are known only from a few collections: *H. conicus* Bas & Weholt, *H. moserianus* Bas, *H. nitens* Maas Geest. & Hauskn., *H. paradoxus* M.M. Moser.

Moreover, several taxa initially described in *Hydropus* have been recognized as belonging to other genera. For instance, Robich (2001) treats *Hydropus floccipes* var. *montis-rosae* Jamoni & Bon in *Mycenella,* while Contu (2001) and Eyssartier & Moreau (2001) treat *H. liciosae* Robich & Contu in *Lactocollybia.*

Within the genus *Hydropus*, *H. floccipes* seems to have the widest ecological range and geographical distribution in western Europe, although it clearly shows Mediterranean trends (Malençon & Bertault, 1975; Robich, 1990; Moreau et al., 1999). Several colour variations have been described (Malençon & Bertault, 1975; Ortega-Diaz & Zea, 1991; Perez-de-Gregorio, 2001) that are reported as microscopically identical to the type.

While exploring peat bogs and mires for his PhD fieldwork, the first author (PAM) gathered three mycenoid collections that were first interpreted as representing an unusual form of *H. floccipes* with conspicuous black-edged gills. A thorough study revealed several differences clearly separating our collections from typical *H. floccipes*. Although no detailed European description fit our material [but see below regarding Einhellinger (1976)], a matching description was found in Smith's (1947) North American monograph under the name *Mycena kauffmanii* A.H. Sm. (1936), a name also cited by Kühner (1938). The descriptions given by Smith, as well as earlier notes by Kauffmann (1918: 792) under the name "*Mycena denticulata* Peck", match perfectly our specimens. Our study of the three abundant collections (including the type) from Smith's herbarium (MICH) fully confirms our initial identification.

Below we describe our collections, after which we compare our concept first with Smith's description of *Mycena kauffmanii* and then with *H. floccipes.*

Material and methods

Studied collections of *H. kauffmanii*: Europe -- France. Isère. Saint-Laurent-du-Pont (M. E. N. 3233D), « tourbière de l'Herretang », alt. 400 m, under *Salix cinerea* and *S. aurita*, on naked soil mixed with twigs of *Salix*, close to *Peziza succosa* var. *infuscata*, 01-IX-2000, herb. P.-A. M. n° 00090110 (ZT); same location, on twigs and pieces of wood of *Salix* buried in a deep dry humus, 04-VI-2001, leg. J.-C. Déiana & P.-A. Moreau, herb. P.-A. M. n° 01060401 (ZT) **Fig. 1, 4. Savoie.** Saint-François-de-Sales (M. E. N. 3332B), "Tourbière des Creusates", alt. 1350 m, under a lone *Salix cinerea* on a piece of twig, in a damp neutrophilic mire with *Molinia caerulea, Aulacomnium palustre, Tomenthypnum nitens* and *Salix repens*, 10-VII-2001, herb. P.-A. M. n° 01071006 (ZT). **Fig. 3-8. Pas-de-Calais.** Merlimont (M. E. N. 2105C), Réserve biologique domaniale, alt. 5 m, in a *Salix* bush (*Salicion auritae*) on alcaline peat, 01-VIII-2003, leg. R. Courtecuisse & P.-A. Moreau, herb. RC/F03.192 (LIP). **North America -- United States. Michigan: Dexter.** Silver Lake, alt. 950 ft, on moss, 11-VI-1934, herb. A. H. Smith n° 13 (NYC 11499, MICH, holotype !). **Fig. 2. Cheboyan Co.** Wolf bog, 29-VI-1941, herb. A. H. Smith n° 23264 (NYC 32364, MICH). **Lakeland**. 24-VI-1935, herb. A. H. Smith n° 1408 (NYC 1408, MICH) [note: collection studied by Kühner, 1937]

Macroscopical and microscopical observations on French material were made on fresh material in H_20 and in Congo red and completed on dry material. Smith's material was rehydrated in 5% KOH before observation. Cyanophily of spore wall was tested in Cotton blue-lactic acid solution, amyloidity and dextrinoidity were tested in Melzer's reagent, and tissue metachromasy was tested in Cresyl blue. Colour reference standard: Séguy (1936). Soil nomenclature following Baize & Girard (1995).

Taxonomy

Hydropus kauffmanii (A. H. Sm.) P.-A. Moreau & Courtec., *comb. nov.*
BASIONYM: *Mycena kauffmanii* A. H. Sm. 1935, Mycologia 27: 588

Description of European collections

Pileus 0,8-2 cm diam., conical-campanulate, then somewhat flattened or umbonate, often depressed around the umbo, with margin remaining straight a long time; edge exceeding, then revoluted, surface dull, almost velvety, not sulcate or becoming so only at late stage, fibrillose-looking in mature specimens; colour uniform and constant, sepia brown (Seguy 116), umbo often somewhat darker.

Lamellae 26-36 arising from the stipe, 2 series of lamellulae, almost free to adnate-uncinate with age or sometimes arcuate-subdecurrent; the faces markedly venose in mature specimens; colour pure white, with pruinose, obviously black-punctate edge.

Stipe 3-7 x 0,1-0,3 cm; light brownish grey, entirely and densely black-powdered, fistulose, insititious on superficial woody debris or +/- rooting (up to 3 cm deep).

Context white, slightly elastic, not fragile, weakly succulent when cut. Smell fruity-acidic, reminding *Fomitopsis pinicola*. Taste none.

Spores (5,5) 6,5-7,5 x 5,5-6,5 μm (8,5-10 x 7,5-8,2 μm from 2-sp. basidia), Q = 1,1-1,3, globose to subglobose in spore print, but often widely ellipsoid on hymenium, with a large apiculus up to 1-1,5 μm long; inamyloid, non-cyanophilic, with 1-guttulate oily content (fresh material). **Basidia** 22-35 x 6-11 μm, 4-spored in PAM 00090110 and 01060401, equally 2-4-spored with a number of 1-3-spored basidia too in PAM 01071006, clavate to clavate-pedonculate with elongated basis, all clamped; sterigmata prominent, up to 5-6 μm long, but monosterigmatic basidia not infrequent with sterigmata up to 8 μm. Subhymenium 15-20 μm thick, ramose with short dichotomously branched elements 2-3 μm wide; basidioles abundant, some undulate-fusiform and shortly protruding. **Cheilocystidia** numerous, 35-55 x 6-13 μm, rather short, clavate or lageniform (sometimes with elongated neck), to cylindrical, subfusiform or with +/- vermiform neck, the lower part always thick and constant in shape; intracellular content abundant, grey-brownish pigmented, especially in the longest cystidia. **Pleurocystidia** absent.

Pileipellis a trichoderm, with densely erected elements towards the disc, these being more scarce and adpressed towards the margin; suprapellis 70-110 μm thick at disc, with abundant pileocystidia 25-80 x 7-15 μm, often arising from deep layers of subpellis, versiform, lageniform or lageni-fusiform to cylindrical or narrowly clavate, mostly with abundant grey-brown intracellular pigment. Subpellis 80-120 μm thick, clearly differentiated, with globose to ellipsoid, sometimes clavate or utriform elements 30-90 x 18-35 μm, with diluted intracellular pigment, mixed with thin, inconspicuous hyphae x 2-3 μm; no gloeoplerous hyphae seen.

Pileus context with long, fusiform elements up to 300 (500) x 15-25 (35) μm, mixed with thin generative hyphae x 2-3 μm; all elements pigmentless, but with scarcely guttulate content.

Lamellar trama parallel, with the same structure than cap context, the fusiform elements up to 300-1200 μm long.

Stipitipellis a cutis of smooth hyphae x 3-5 μm, without differentiated cortex, with numerous fascicles of 10-25 caulocystidia, 40-65 x 5-12 μm, mostly clavate, smooth, with dark grey-brown, intracellular pigment, mixed with short and scarce filiform diverticules up to 25 μm long. Stipe context with parallel, poorly differentiated hyphae x 3-5 μm, mixed with gloeoplerous hyphae showing refractive content, x 3-4 μm, conspicuous but not abundant. No part of basidiomata metachromatic or dextrinoid on fresh material; basal part of the stipe weakly dextrinoid in *exsiccata*.

Clamps abundant in all tissues, sometimes scarce in context and among pileipellis hyphae, often very large.

Ecology: found twice (Saint-Laurent-du-Pont, Isère, F) in a mesotrophic *Salix cinerea-S. aurita* stand, with neutral pH (6,5-7); the site is an alkaline peat bog with 40-60-year-old willow bushes developed after drainage; the initial hydromull humus has become a deep dysmull with abundant litter, rich in twigs and small woody pieces of *Salix*. Basidiomata were abundant on the woody debris, with 12-18 gregarious specimens discovered at 2 different sites each time). Found once (Les Creusates, St-François-de-Sales, F) in the neutrophilic part of a mixed peat bog under a lone *Salix cinerea* surrounded by a *Molinia caerulea-Aulacomnium palustre* dominated association with pH about 5,0 (related to *Caricion canescenti-fuscae*); the only specimen was linked to a small woody remnant of *Salix*. The last record was collected from an alkaline *Salix* stand in a coastal dune system with *Populus tremula* and *Betula pubescens* also present. The single specimen grew in a rather thick litter of leaves and woody twiglets of *Salix aurita*. Although quite distant from the first locality, the ecological conditions so resembled Saint-Laurent, that the first author (PAM) jokingly predicted finding the species just a few minutes before the second author (RC) actually found the small specimen. The species is assumed to be lignicolous and associated with *Salix*, growing on small pieces of wood buried in neutrophilic to basic peaty humus. It may fructify from June to September.

Observations on type specimens

Three Smith collections preserved in NYC were studied; all were found to conform perfectly to Smith's (1936, 1947) descriptions. The holotype (of which only one½ specimen was examined) matches exactly all microscopical features found in the European material; 2-spored basidia are scarce, but large spores up to 10 x 8 μm are not rare on the hymenium and due to age, the suprapellis of the type specimen has thinned so that a dense trichoderm is present only in patches. Collection AHS1418, was examined and well described by Kühner (1938: 546). Collection AHS32364 is beautiful (more than 30 specimens in perfect condition) and none of the 5 specimens studied showed divergences with the previously observed ones. It should be noted that all A. H. Smith exsiccati have butter-yellow lamellae and red-brownish pilei, somewhat lighter than European material.

Discussion

Mycena kauffmanii was described by Smith (1936, 1947) as occurring "around elm and ash stumps or on humus in elm and ash swamps", after Kauffman (1918: 792) described it erroneously as "*Mycena denticulata* Peck". Kühner (1938: 546) refined the description and provided spores and cheilocystidia drawings after examining Smith's material. We confirmed Kühner's observation of a weak amyloidity and purplish-violaceous coloration on walls of stipe hyphae in Cresyl blue in the American material, but these reactions were very weak (also on dry material, only cortex ochre-reddish in

Melzer) in our French material. This last character can be discussed in comparison with the closely related *H. floccipes*, where amyloidity and metachromasy can be present or not (Malençon & Bertault, 1975: 261).

Undoubtedly, our collections of *Mycena kauffmanii* are strongly reminiscent of *Hydropus floccipes* (Fr.: Fr.) Singer. Although we are well acquainted with *H. floccipes* (Moreau et al., 1999), we first thought we had found it in an unusual habitat. But our attention was caught by the black-serrulate gill edge, no mention of which was found in any of the usual descriptions of *H. floccipes* (Maire, 1928: 41 – as *Mycena maura*; Kühner, 1938: 540; Smith, 1947: 380; Singer, 1982: 118; Bon & Chevassut, 1989: 33; Robich, 1990: 317; Hausknecht et al., 1997: 186; Pérez-de-Gregorio in Societat Catalana de Micologia, 1998: 823; Watling & Turnbull, 1998: 132). Microscopical differences are sufficient to exclude identifying our collections as any of the described varieties or forms of *H. floccipes*; the densely erected pileal trichodermium, the lack of pleurocystidia and gloeoplerous hyphae in gill trama, and the non strictly globose spores all exclude *H. floccipes*. The two species are compared below in **Table 1**.

Smith (1947: 379), in his key to sect. *Floccipedes*, emphasizes the black gill edge of *H. kauffmanii* as the determinant character for segregating it within the section. In fact, Smith does not write many lines to compare *M. kauffmanii* with *M. floccipes*, since the microscopical descriptions are obviously different for him. The pileipellis structure looks very distinctive, and the numerous "cystidium-like projections" from hypodermium explain the "subvelvety" surface. This is actually a major difference with *H. floccipes*, which shows a typical cutis-structure; in fact, we observed in our material of *H. kauffmanii* that the typical *Hydropus* structure with parallel inflate hyphae is present, but widely dominated by emergent pileocystidia arising from different layers of subpellis as described by Smith. The remarkable development of pseudoparenchymatous subpellis, which reminds of a typical *Mycena*-structure, is a unique feature as far as European *Hydropus* are concerned.

The deeply rooting stipe is also emphasized for *M. kauffmanii* in the key and discussion by Smith (loc. cit.), but this feature can be influenced by the buried substrate. In the hereby described collections, only some of the specimens were linked with deeply buried *Salix* twigs (up to 3 cm deep), and then the stipe was rooting as described and illustrated by Smith; but other specimens fixed on only slightly buried twigs do not show conspicuous pseudorrhiza. The same substrate-dependent polymorphy can be observed in *H. floccipes*, usually growing on bark but sometimes arising from buried pieces of wood and then with pseudorrhiza (Malençon & Bertault, 1975: 261; Bas, 1999: 167; see Moreau et al., 1999, pl. 1A).

Smith (1947) does not mention explicitly the absence of pleurocystidia in *M. kauffmanii* (but Kauffman, 1918: 793, writes "Cystidia none" in his description of *M. denticulata*) although he mentions them abundant in *H. floccipes*; he does not mention either gloeoplerous hyphae for both species. This difference in pleurocystidia is nevertheless conspicuous, but should be derived from the absence of gloeoplerous hyphae in the subhymenium of *H. kauffmanii*, when the pleurocystidia (pseudocystidia) of *H. floccipes* are issued from the numerous gloeoplerous hyphae running into its subhymenium (Moreau et al., loc. cit.).

In recent times, no mycenoid specialist seems to have reported on *Mycena kauffmanii*, and the combination in *Hydropus* Singer seems still unpublished. *H. kauffmanii* undoubtedly belongs in that genus because of its typical sarcodimitic trama, intracellular pigmentation, and presence of cheilocystidia. Subglobose, non-amyloid spores place it in sec. *Floccipedes* Kühner ex Singer, subsec. *Floccipedes* according to the European classification (Contu & Robich, 1998, Bas, 1999); but Singer's classification (1982: 53) based on a hymenodermic pileipellis and absence of pleurocystidia would place it insect. *Mycenoides* Singer, subsect. *Anthidepades* Singer, which has not yet been reported from temperate areas. Because the subsect. *Anthidepas* looks highly artificial and contains species that share only negative characters (inamyloid spores and lack of pleurocystidia; Singer, 1982), we prefer to follow the conservative path by retaining *H. kauffmanii* in sect. *Floccipedes* sensu Smith (1947).

In Singer's (1982) monograph of South American species of *Hydropus*, *H. kauffmanii* would key out closely to another species sharing dark colours and black edges: *H. nigromarginatus* Singer, which differs in producing decurrent pinkish gills and cheilocystidia with granules that turn blackish to lilac in iodine. The dark and granulose pileus of *H. fraterniger* Singer (Singer, 1946) also resembles that of *H. kauffmanii,* which has already been reported from Europe (Austria: Hausknecht et al. 1997, although the identification is considered dubious by Esteve-Raventós et al., 2002); it differs from *H. kauffmanii* mainly by pale gill edge, 2-spored basidia and amyloid spores.

Another member of subsect. *Floccipes* should be *Mycena ulmicola* A.H. Sm. (Smith, 1939: 281; 1947: 382), which seems to be as neglected as *M. kauffmanii* in current literature. According to Smith's discussion, its characters are closer to those of *H. floccipes*, except small spores (3,5-4 μm) and rarefaction of pleurocystidias from the edge. A collection from Switzerland (Favre, 1957) is the only report of *M. ulmicola* from Europe, with some minor divergences in microscopical features.

Our collections of *H. kauffmanii* should not be the first ones from Europe: Einhellinger (1976) briefly reports under the name "*Hydropus floccipes*" a collection from alkaline bog in Bavaria, with black gill edge, which could fit with *H. kauffmanii*. Unfortunately no description is published of this collection, and no material could be found in Einhellinger's herbarium in Munich (D. Triebel, pers. comm.).

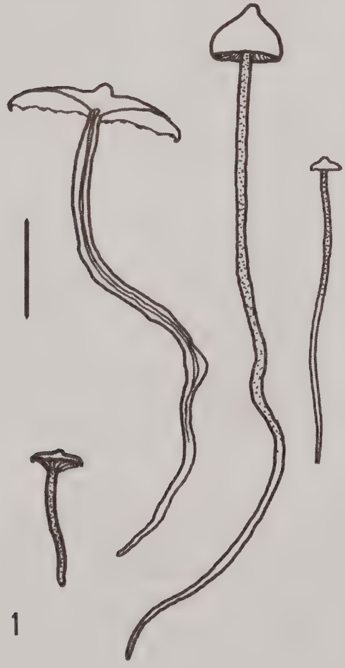
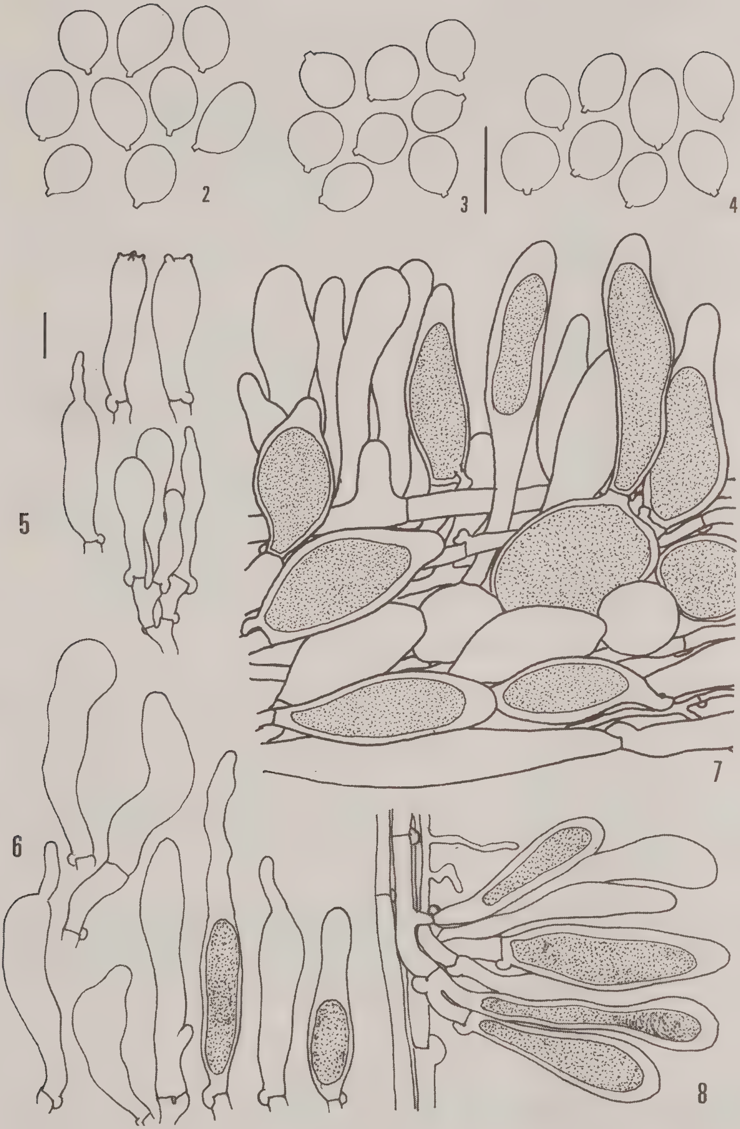


Fig. 1: *Hydropus kauffmanii*. Sporophores (PAM 01060401). Scale = 10 mm.



Figs. 2-8: *Hydropus kauffmanii*. 2: spores (holotype, NYC 11499). 3: spores (PAM 01060401). 4: spores (PAM 01071001). 5: basidia and basidioles; 6: cheilocystidia; 7: pileipellis (radial cut); 8: stipitipellis (PAM 01071001). Scale = 10 μm.

Table 1. Comparison of distinctive characters in *Hydropus floccipes* and *H. kauffmanii*

	H. floccipes	***H. kauffmanii***
Cap	Smooth, slightly fibrillose.	Matte, almost velvety at least at centre, later fibrillose-radiate.
Gills	Pure white, edge pruinose, white.	Pure white, edge pruinose, but with black punctuations along the edge.
Spores	5,5-7,5 μm, globose.	6,5-7,5 x 5,5-6,5 μm, globose to widely ellipsoid.
Cheilocystidia	40-60 x 6-8 μm, with hyaline content.	35-55 x 6-13 μm, most with brownish content on fresh and dried material.
Pleurocystidia	60-100 x 12-22 μm, very numerous.	Absent.
Pileipellis structure	10-15 μm thick, a cutis with inflated cystidia-like protuberances up to 25 μm long. Subpellis filamentous, with long hyphae 60-150 x 8-20 μm.	70-110 μm thick, a trichoderm with cystidia arising from subpellis, mixed with scarce thin, radial hyphae. Subpellis pseudoparenchymatous, with globose to shortly ellipsoid hyphae 30-90 x 18-35 μm.
Caulocystidia	30-40 x 5-10 μm.	40-65 x 5-12 μm.
Gloeoperous hyphae	Very abundant in subpellis, gill and stipe trama.	Abundant only in stipe trama, rare and scarce in subpellis and gill trama.
Habitat	On bark or rotten wood, usually of *Quercus spp.*, rather thermophilous.	On buried twigs of *Salix, Ulmus, Fraxinus*, in wet habitats.

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Literature cited

Baize D, Girard MC (coord.). 1995. Référentiel pédologique. I.N.R.A. Editions: Versailles. 332 pp

Bas C 1999. 8. *Hydropus* (Kühner) ex Singer. *In*: Bas C., Kuyper T. W., Noordeloos M. E., Vellinga E. C. Flora Agaricina Neerlandica. Rotterdam, A. A. Balkema: 166-172.

Bon M, Chevassut G 1989. Agaricomycètes de la région Languedoc-Cévennes (4ème partie). Doc. Mycol. 19 (75): 25-46, pl. I.

Contu M, Robich G 1998. *Hydropus liciosae spec. nov.*, con chiave per la determinazione delle specie del genere *Hydropus* in Europa. Revista Micol. 41 (2): 109-118.

Contu M, 2000. Il genere *Lactocollybia* (Agaricales, Tricholomataceae) in Sardegna. Boll. Assoz. micol. ecol. romana. 49-50: 9-15.

Einhellinger A 1976. Die Pilze in primären und sekundären Pflanzenschaften oberbayerischer Moore. Teil 1. Ber. Bayer. bot. ges. 47: 75-149.

Esteve-Raventós F, Villarreal M, Heykoop M 2002. *Hydropus paradoxus* var. *xerophyticus* and a key to the taxa known from Europe. Persoonia 17 (4): 631-635.

Eyssartier G, Moreau PA 2001. Notes sur quelques espèces intéressantes de Basidiomycètes récoltées en Corse. Bull. Féd. Assoc. Mycol. Médit. 20: 11-22.

Favre J 1957. Mycènes nouvelles ou peu connues. Bull. Soc. neuchâteloise Sci. nat. 80: 81-98.

Hausknecht A, Krisai-Greilhuber I, Klofac W 1997. Die Gattung *Hydropus* in Österreich. Österr. Z. Pilzk. 6: 181-210.

Kauffman CH 1918. The *Agaricaceae* of Michigan, vol. I, text. Michigan Geol. Biol. Survey 26, Biol. Ser. 5. Lansing, Michigan. 924 pp

Kühner R 1938. Le genre *Mycena* (Fries), étude cytologique et systématique des espèces d'Europe et d'Amérique du Nord. Lechevallier: Paris. 710 pp [Encyclopédie Mycologique vol. 10]

Machol RE, Singer R 1978 (1977). Taxonomic position of *Hydropus floccipes* and allied species – a quantitative approach. Mycologia 69 (6): 1162-1172.

Maire R 1928. Diagnoses de champignons inédits de l'Afrique du Nord. Bull. Soc. mycol. France 44 (1): 37-56, pl. 1-5.

Malençon G, Bertault R 1975. Flore descriptive des champignons supérieurs du Maroc, tome II. Trav. Inst. Cherifien, Fac. Sci. Rabat 43, 539 p.

Moreau PA, Roux P, Garcia G 1999. Remarques sur l'anatomie de trois espèces mycénoïdes à spores rondes: *Hydropus floccipes, Mycenella favreana* et *M. salicina*. Doc. mycol. 29 (115): 1-12.

Ortega Díaz A, Zea M 1991. *Hydropus floccipes* var. *luteipes* Ortega & Zea *var. nov*. en España meridional. Bol. Soc. micol. Madrid 15: 189-191.

Pérez-de-Gregorio MÀ 2001. *Hydropus floccipes* (Fr.) Singer f. *luteipes* (A. Ortega et Zea) Pérez-De-Gregorio *stat. nov*., a Catalunya. Rev. Catalana Micol. 23: 91-93

Robich G 1990. Alcuni *Hydropus* delle nostre regioni. II° contributo. Rivista Micol. 33 (3): 314-321.

Séguy E 1936. Code universel des couleurs. Encyclopédie pratique du naturaliste, 30. P. Lechevallier: Paris. 68 pp

Singer R 1946. A new species of *Hydropus* (Kühn.) Sing. (Agaricales). Mycologia 38: 227-228.

Singer R 1982. *Hydropus* (*Basidiomycetes – Tricholomataceae – Myceneae*). Flora Neotropica, 32: 1-152.

Singer R 1986. The *Agaricales* in modern taxonomy, ed. 4. Koeltz: Königstein. 981 pp

Smith AH 1935. Studies in the genus *Mycena*, II. Mycologia 27: 586-604.

Smith AH 1939. Studies in the genus *Mycena*, V. Mycologia 31: 267-285.

Smith AH 1947. North American species of *Mycena*. Univ. Michigan Studies, Sci. Ser. 17: 1-121.

Societat Catalana de Micologia 1998. Bolets de Catalunya. XVII collecció. Barcelona, pl. 801-850.

Watling R, Turnbull E 1998. 8 / *Cantharellaceae, Gomphaceae* and amyloid-spored and xeruloid members of *Tricholomataceae* (excl. *Mycena*). *In*: Henderson D. M., Orton P. D., Watling R. (Eds.), British Fungus Flora, Agarics and Boleti. Royal Botanical Garden : Edinburgh. 189 pp

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Revision and nomenclature of several boletes in China

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Abstract— Revision of several boletes in China is reported with proposals of a new name and two new combinations. *Boletus atratus* is proposed as *nomen novum* to replace *B. nigricans* M. Zang, M. S. Yuan & M. Q. Gong, which is a later homonym of *B. nigricans* Pat. & Baker. This is considered as a recognizable species based on examination of the type material from China in comparison with specimens of *B. nigerrimus* and *Tylopilus alboater*. *Boletinus cavipoides* and *B. kunmingensis* are transferred to *Suillus* as the new combinations *S. cavipoides* and *S. kunmingensis* respectively, based on the characters of viscid pileus and the absence of clamp connexions in tube trama hyphae. A revision of the type material of *S. pinetorum* is also presented to extend the species description and to clarify the nomenclature of the species.

Key words—*Boletales*, *Boletus* sect. *Nigres*, type revision

中文摘要

本文报道对中国产的4种牛肝菌的研究结果，提出了1个新名称和2个新组合。建议以新名称*Boletus atratus*取代*B. nigricans* M. Zang, M. S. Yuan & M. Q. Gong（黑牛肝菌，汉语学名保留不变），因为后者是*B. nigricans* Pat. & Baker的晚出同名。经与近缘种*B. nigerrimus*（黑紫牛肝菌）和*Tylopilus alboater*（黑盖粉孢牛肝菌）等进行比较，确认*Boletus atratus*是一个独立的种。根据菌盖胶粘及菌髓菌丝不具锁状联合等特征，将*Boletinus cavipoides*（类小牛肝菌）和*B. kunmingensis*（昆明小牛肝菌）归并到*Suillus* (粘盖牛肝菌属)中，构成*Suillus cavipoides*（类小粘盖牛肝菌）和*S. kunmingensis*（昆明粘盖牛肝菌）两个新组合。基于模式标本的观察，本文也对*S. pinetorum*（松林粘盖牛肝菌）进行了重新描述，并对中国文献中出现的命名法问题作了讨论。

Introduction

The boletes, or fleshy pore fungi, are a group of fungi mostly living symbiotically with plants, forming ectomycorrhizal associations (Smith & Thiers 1971, Corner 1972,

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Singer 1986, Bessette et al. 2000). Ectomycorrhizal basidiomycetes, including most boletes, constitute an important component of forests fungal communities (Dahlberg et al. 1997, Smith & Read 1997, Baxter & Dighton 2001) and count greatly in the ecosystem of forest. Many species are edible and delicious (Singer 1986, Smith & Thiers 1971, Bessette et al. 2000), although some others are poisonous. Boletes are the main wild fungi exported in large quantity from China to Japan, Italy, France, Switzerland, etc. The exported boletes (including their products) from a province of China, Yunnan, reached 6053.2 tons in 2000, generating US$ 19.3 million of income for the province (www.unn.com.cn/GB/channel23/176/).

Boletes are usually placed in *Boletales* E.-J. Gilbert 1931, with about 1025 species worldwide (Kirk et al. 2001), with more than 350 species distributed in China (Li & Song 2000). Investigation by Chinese mycologists of species of *Boletus* Fr. 1821, *Xerocomus* Quél. 1888 and *Boletinus* Kalchbr. 1867 in China has revealed several new species in *Boletinus* (e.g. Chiu 1948, Zang 1980, Bi et al. 1982) and one in *Boletus* (Zang et al. 1993). Among the new species described from China, *B. nigricans* M. Zang, M. S. Yuan & M. Q. Gong 1993 is found to be a later homonym of *B. nigricans* Pat. & Baker 1918. Re-examination of holotypes of these taxa and other relevant specimens preserved in Herbarium, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS), Mycological Herbarium, Institute of Microbiology, Chinese Academy of Sciences (HMAS) and Herbarium, Guandong Institute of Microbiology (HMIGD) has provided some noteworthy information on several boletes. The results are presented in this paper.

Taxonomy

Boletus atratus Q. B. Wang & Y. J. Yao, **nom. nov.**
≡*Boletus nigricans* M. Zang, M. S. Yuan & M. Q. Gong in *Acta Mycol. Sin.* 12: 278 (1993). non *Boletus nigricans* Pat. & Baker in *J. Straits Branch R. A. Soc.* 78: 70 (1918).

Etym.: atratus, black; referring to the color of the fruitbody.

Pileus 6.0–9.0 cm in diam., subconvex to plane, velvety-tomentose, aerolate, dark brown to black. *Context* 1.0 cm thick at stipe, dark gray brown, taste and odor mild. *Tubes* 0.6–1.0 cm long, dark brown, depressed around the stipe apex; pores 9–11 pores/cm, multi-angular, concolorous with the tubes. *Stipe* 6.5–8.5 cm long, 0.7–1.2 cm thick, enlarged downward, concolorous with the pileus, reticulate at least on the upper half, solid. *Basidiospores* 9.0–11.0 x 4.0–5.0 μm, broad ellipsoid, thin-walled, olive brown to brown. *Basidia* 26–36 x 8.0–11.0 μm, clavate, 2- and 4-spored. *Pleurocystidia* 42–63 x 9.0–19.0 μm, thin-walled, fusiform. *Tube trama* poorly rehydrating, hyphae brownish in KOH. *Clamp connexions* absent.

Specimen examined: **China: Sichuan Province,** Pujiang County, Datang, alt. 650 m, 10 June 1991, M. S. Yuan No. 1334, HKAS 23843 (HOLOTYPE).
Habit and habitat: Scattered to solitary in the forest under *Pinus massoniana* and *Camellia oleifera*.
Distribution: China, Sichuan Province (type locality).

The above description is based on the holotype deposited in HKAS. For detailed description of field characters, please see Zang et al. (1993). However, the stipe color was not mentioned by Zang et al. (1993). According to the type material and the color photographs in Yuan & Sun (1995), the stipe is concolorous with the pileus. Based on this species, Zang et al. (1993) proposed a new section within the genus *Boletus*, *B.* sect. *Nigres* M. Zang, which is mainly characterized by the dark context, unchanging tube color when bruised and the reticulate stipe. Six species with diverse characters, i.e. *B. badius* Fr. 1828, *B. brunneissimus* W. F. Chiu 1948, *B. nigerrimus* Heim 1963, *B. tomentulosus* Zang et al. 1991, *B. umbrinellus* Pat. & Baker 1918 and *B. umbrinus* Pers. 1825, were subsequently added to the section (Zang 1999).

There are different treatments of the taxonomic position of *B. nigricans*. By studying the type material, Singer (1947) placed this species in *Tylopilus* P. Karst 1881 as *T. nigricans* (Pat. & Baker) Singer and pointed out that it was very close to *T. alboater* (Schwein.) Murrill 1909, but different only in smaller size of carpophores, the shape of cystidia and spores. After re-examination of the type of *B. alboater* Schwein. 1822, Corner (1972) regarded *B. nigricans* as a synonym of *B. alboater* on the basis of the description of and notes on the type of the former by Singer. We agree with Corner (1972) that *B. nigricans* and *B. alboater* (≡ *T. alboater*) are conspecific.

Zang et al. (1993) noticed that *B. atratus* (as *Boletus nigricans* M. Zang et al.) was similar to *B. nigerrimus*. According to Corner (1972), the latter has a sooty pileus often with a purple tint, and a fuliginous olive or greenish olive to olivaceous buff stipe with wholly black scurfy pruinose reticulation and white mycelium at the base. In contrast, *B. atratus* has sooty black to black pileus without purple tint, sooty to black stipe with fine reticulation at least on the upper half and black mycelium at the base.

In fact, *B. atratus* is closer to *T. alboater*, which has velvety black to dark grayish brown pileus and concolorous stipe sometimes with reticulation at the apex. The black hymenophore, black and unchanging context of the pileus when bruised, and a stipe with reticulation sometimes on the lower half and with black mycelium at the base in *B. atratus* (see Zang et al. 1993) make it distinguishable from *T. alboater*, which has a pinkish or flesh colored hymenophore, pallid white or yellowish white context eventually blackening, and a stipe without reticulation on the lower half and with white mycelium at the base in the latter. However, the black hymenophore and the black context seldom appear in the genus *Boletus*. Whether *B. atratus* is a member of *Boletus* or *Tylopilus* may be determined when the two genera are better circumscribed.

Suillus cavipoides (Z. S. Bi & G. Y. Zheng) Q. B. Wang & Y. J. Yao, **comb. nov.**
≡*Boletinus cavipoides* Z. S. Bi & G. Y. Zheng in *Acta Bot. Yunnan.* 4: 58 (1982).

Pileus 1.8–5.5 cm in diam., subconvex to plane, tomentose, very viscid when moist, pale yellow to pale yellow brown. *Context* 3–8 mm thick, pale yellow, concolorous with the pileus, unchanging when bruised, odor and taste mild. *Tubes* 3 mm long, yellow, unchanging when bruised, decurrent around the stipe; pores 1–2 pores/mm, nearly circular to sub-multiangular, compound, radically arranged, yellow, unchanging when bruised. *Stipe* 2.2–4.5 cm long, 0.4–0.7 cm thick, cylindric, pale brown or concolorous with the pileus, hollow when mature. *Basidiospores* 5.0–9.0 x 3.0–4.0 μm, mostly 7.0–8.0 x 3.0 μm, narrowly elliptical, smooth, thin-walled, olive brown. *Basidia* 13.0–27 x 5.0–7.0 μm, clavate, 2- and 4-spored. *Pleurocystidia* 37–48 x 5.5–8.0 μm, clavate. *Tube trama Boletus*-type, divergent from a central strand. *Clamp connexions* absent.

Specimens examined: **China: Guangdong Province**, Dinghu, Caotang, 19 April 1981, Z. S. Bi, HMIGD 4819; Dinghu Mountains, in mixed woods, 12 May 1981, Z. S. Bi et al., HMIGD 4901; Dinghu Mountains, 9 May 1982, Y. Z. Wang & J. Q. Liang, HMIGD 5769.
Habit and Habitat: Gregarious in mixed forest.
Distribution: China, Guangdong Province (type locality).

The type material of this species cannot be located in HMIGD where it was housed. The above description is based on other specimens (HMIGD 4901, 5769) determined by Z. S. Bi. Re-examination of these specimens shows spores of 5.0–9.0 x 3.0–4.0 μm, mostly 7.0–8.0 x 3.0 μm, basically in accord with those by Bi et al. (1982, 7–10.5 x 3–3.5μm). This is an easily recognized species and is close to *S. cavipes* (Opat.) A. H. Sm. & Thiers 1964, which has a dull yellow to dark reddish brown pileus (Smith & Thiers 1964, 1971). However, the viscid and tomentose pileus distinguishes *Suillus cavipoides* from *S. cavipes*. The absence of clamp connexions in tube trama hyphae and the viscid pileus strongly suggest it to be a member of *Suillus* S. F. Gray 1821.

Boletinus and *Psiloboletinus* Singer 1945 have traditionally been classified with *Suillus* (e.g. Singer 1945, 1975), largely on the boletinoid hymenophore and the elongate spores (Pegler & Young 1981). Characters used to differentiate *Boletinus* from *Suillus* are the presence of clamp connexions, a sterile stipe surface without granular dots, the absence of a viscid or glutinous layer on the pileus and fasciculate encrusted pleurocystidia (Kretzer et al. 1996, Singer 1975, 1986). However, these characters are not consistent (Singer 1962). It is well known that species of *Suillus sensu stricto* are also able to develop clamp connexions in mycelial cultures (Hübsch 1961, Pantidou & Groves 1966). Smith & Thiers (1964) reduced *Boletinus* to a section of the genus *Suillus*. Singer (1975, 1986) restricted the genus to three species (*B. asiaticus* Singer 1938, *B. cavipes* (Opat.) Kalchbr. 1867 and *B. paluster* (Peck) Peck 1889), which are characterized by the presence of clamp connexions in their fruitbodies (Kretzer et al. 1996). Kretzer et al. (1996) proved neither *Boletinus* as defined by Singer (1975, 1986) nor *Fuscoboletinus* Pomerleau & A. H. Sm. 1962 to be a monophyletic group. Molecular phylogenetic analysis (Kretzer et al. 1996) based on the internal transcribed spacer sequences (ITS) strongly supports the concept of a genus *Suillus sensu lato*, which comprises both *Boletinus* and *Fuscoboletinus*, as introduced by Bruns & Palmer (1989).

Suillus kunmingensis (W. F. Chiu) Q. B. Wang & Y. J. Yao, **comb. nov.**

≡*Boletinus kunmingensis* W. F. Chiu in *Mycologia* 40: 199 (1948).

Pileus 3.0–5.0 cm in diam., hemispherical then becoming broad convex to plane, flesh, ochre, cinnamon-brown or orange-cinnamon, very viscid when moist, glabrous, margin wavy. *Context* pale yellow, deeper at the center, unchanging when bruised. *Tubes* 3–4 mm long, pale peach yellow to buff yellow, unchanging when bruised; pores about 8–10 pores/cm, multi-angular, radically arranged, pale yellow to brown, unchanging when bruised, short decurrent down to the stipe. *Stipe* cylindric or tapering downward, 3.0–4.0 cm long, 5–7 mm thick, pale yellow, dotted with dark-colored granules overall, solid; context yellowish, paler than that of the cap. *Basidiospores* 9.0–12.0 x 4.0–5.0 μm (mostly 10.0–11.0 x 5.0 μm), narrowly ellipsoid, smooth, thin-walled, pale olive brown to pale brown. *Basidia* 24–32 x 6.0–10.0 μm, clavate, 2- and 4-spored. *Pleurocystidia* 36–53 x 6.0–11.0 μm, clavate. *Tube trama* poorly rehydrating. *Clamp connexion* absent.

Specimen examined: **China: Yunnan Province**, Kunming, Tiefeng'an, 12 Nov. 1930, W. F. Chiu, HMAS 3695 (Tsinghua 7695, HOLOTYPE).
Habit and Habitat: Solitary on the ground in a mixed forest (Yuan & Sun 1995).
Distribution: China, Sichuan (Yuan & Sun 1995) and Yunnan (type locality) Provinces.

The description of microscopic characters is based on examination of the holotype. Chiu (1948, 1957) did not measure the sizes of basidia and pleurocystidia, but provided a good description of the macro-features which are followed here.

Suillus kunmingensis is close to *S. pinetorum* (W. F. Chiu) H. Engel & Klofac 1996 and *S. punctatipes* (Snell & E. A. Dick) Snell & E. A. Dick 1961, which all have a brown or cinnamon brown and viscid pileus, and a stipe glandular-dotted at the upper half (see below and also Snell & Dick 1941, Bessette et al. 2000). However, the spores of *S. kunmingensis* (9.0–12.0 x 4.0–5.0 μm) are larger than those of the latter two species, 7.0–9.0 (–10.0) x 3.0–4.0 μm in *S. pinetorum* and 7–10 x 3–3.5μm in *S. punctatipes* (Snell & Dick 1941, 1961). Further, the stipe of *S. kunmingensis* has an entirely granular stipe, compared with granular dots on the upper part of the stipe in both *S. pinetorum* and *S. punctatipes*. As discussed above, species of *Boletinus* can not be separated from that of *Suillus* (Kretzer et al. 1996). The very viscid pileus, the granular stipe and the absence of clamp connexion in tube trama hyphae also show *Boletinus kunmingensis* to be a species within the genus of *Suillus*.

Suillus pinetorum (W. F. Chiu) H. Engel & Klofac in Engel et al., *Schmier- und Filzrohrlinge s.l. in Europa. Die Gattungen* Boletellus, Boletinus, Phylloporus, Suillus, Xerocomus: 12 (1996).
≡*Boletinus punctatipes* Snell & E. A. Dick var. *pinetorum* W. F. Chiu in *Mycologia* 40: 200 (1948).
≡*Boletinus pinetorm* (W. F. Chiu) Teng, *Fungi of China*: 346 (1962).
≡*Suillus pinetorum* (W. F. Chiu) T. H. Li in Z. S. Bi et al., *Prelim. Agaric Flora Hainan Prov.*: 278 (1997), superfluous comb.

Pileus 4.5–5.0 cm in diam., hemispherical, becoming subconvex to plane, glabrous, very viscid when moist, cinnamon brown to brown, often with a red tone. *Context* 1.0–1.5 cm thick at the stipe, pale red orange, unchanging when bruised, taste and odor mild. *Tubes* 0.5 cm long, dark yellow-brown, unchanging when bruised, decurrent down the stipe; pores 5–8 pores/cm, multi-angular, compound, radiately arranged, concolorous with tubes, unchanging when bruised. *Stipe* cylindric, 2.0–3.0 cm long, 0.5–1.5 cm thick, concolorous with the cap or paler, with brown dots on the upper part, reticulation absent, solid. *Basidiospores* 7.0–9.0 (–10.0) x 3.0–4.0 μm, mostly 8.0 x 3.0 μm, narrowly ellipsoid, smooth, thin-walled, pale olive brown to pale brown. *Basidia* 21–32 x 5.0–7.0 μm, clavate, sterigmata 3.0–8.0 μm long, 2-, 3- and 4-spored. *Pleurocystidia* 43–53 x 5.0–8.0 μm, long clavate. *Tube trama* subparallel, somewhat divergent toward the subhymenium. *Clamp connexions* absent.

Specimens examined: **China: Yunnan Province**, Nanhua Market, 31 Aug. 2002, Q. B. Wang No. 80, HMAS 83652; and 12 Aug. 2003, Q. B. Wang No. 215, HMAS 85234; Songming, Baiyi Wild Mushroom Market, 25 Aug. 2002, F. Q. Yu No. 930, HKAS 41746; Kunming, 11 July 1941, W. F. Chiu, HMAS 3717 (Tsinghua 7717, HOLOTYPE). **Fujian Province**, Shaowu, Baoji, in mixed forest, 8 Sept. 1957, B. N. Jiang No. 3, HMAS 23853; Nanjing, Nankeng, Daji, on the ground, 14 June 1958, S. C. Teng No. 5869, HMAS 22797. **Hunan Province**, Longshan, on the ground, 30 Oct. 1958, Q. T. Chen & L. S. Liang, No. 1368, HMAS 26073.
Habit and Habitat: Scattered to solitary in the forest of *Keteleeria* spp. and *Pinus* spp.
Distribution: China, Fujian, Hunan and Yunnan Provinces.

The newly obtained specimens cited above from Yunnan from 2002–2003, match the description by Chiu (1948, 1957), except for the size of the basidia and pleurocystidia not mentioned originally. The type and the early collections also exhibit abundant pleurocystidia.

Accepting only *Boletus* and *Boletinus* in the family *Boletaceae*, Chiu (1948, 1957) described the above taxon as a variety under *Boletinus punctatipes*, noting that it differs from the species in the pale red cinnamon to pale red brown stipe compared with the white stipe with brown tints in the latter (Snell & Dick 1941). Teng (1963) elevated it to the species level on the basis of the difference mentioned above. Because of the viscid pileus and the absence of clamp connexions in tube trama hyphae, both *B. pinetorum* and *B. punctatipes* have been transferred to *Suillus* as *S. punctatipes* and *S. pinetorum* respectively. Phylogenetic analysis based on ITS sequenced performed in this laboratory (data unpublished) also supports this result.

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Literature cited

Baxter JW, Dighton J. 2001. Ectomycorrhizal diversity alters growth and nutrient acquisition of grey birch (*Betula populifolia*) seedlings in host-symbiont culture conditions, *New Phytologist* **152**: 139–149.

Bi Z-S, Lu D-J, Zheng G-Y. 1982. Basidiomycetes from Dinghu Mountain of China. II. Some new species of Boletaceae (1). *Acta Botanica Yunnanica* **4**: 55–64. (in Chinese).

Bessette AE, Roody WC, Bessette AR. 2000. *North American Boletes, a Color Guide to the Fleshy Pored Mushrooms*. Syracuse: Syracuse University Press, 396 pp.

Bruns TD, Palmer JD. 1989. Evolution of Mushroom Mitochondrial DNA: *Suillus* and related Genera. *Journal of Molecular Evolution* **28**: 349–362.

Chiu W-F. 1948. The Boletes of Yunnan. *Mycologia* **40**: 199–231.

Chiu W-F. 1957. *Atlas of the Yunnan Boletes*. Beijing: Science Press. 154 pp. (in Chinese).

Corner EJH. 1972. *Boletus in Malaysia*. Singapore: Government Printer. 263 pp.

Dahlberg A, Jonsson L, Nylund JE. 1997. Species diversity and distribution of biomass above and below ground among ectomycorrhizal fungi in an old-growth Norway spruce forest in south Sweden. *Canadian Journal of Botany* **75**: 1323–1335.

Hübsch P. (1961). Das Vorkommen von Schnallen bei Boletaceen. *Zeitschrift für Mykologie* **27**: 110–113.

Kirk PM, Cannon PF, David JC, Stalpers JA. 2001. *Ainsworth & Bisby's Dictionary of the Fungi*. 9th Edition. Wallingford: CAB International. 655 pp.

Kretzer A, Li Y, Szaro T, Bruns TD. 1996. Internal transcribed spacer sequences from 38 recognized of *Suillus sensu lato*: Phylogenetic and taxonomic implications. *Mycologia* **88**: 776–785.

Li T-H, Song B. 2000. Chinese boletes: a comparison of boreal and tropical elements. In Walley A. J. S. [ed] *Tropical Mycology. The Millenium Meeting on Tropical Mycology, Main Meeting 2000*, p 4. Liverpool: Liverpool John Morres Univeristy and British Mycological Society.

Pantidou ME, Grooves JW. 1966. Cultural studies of Boletaceae: some species of *Suillus* and *Fuscoboletinus*. *Canadian Journal of Botany* **44**: 1371–1392.

Pegler DN, Young TWK. 1981. A natural arrangement of the Boletales with reference to spore morphology. *Transactions of the British Mycological Society* **76**: 103–146.

Singer R. 1945. The Boletineae of Florida with notes on extralimital species. II. The *Boletaceae* (*Gyroporoideae*). *Farlowia* **2**: 223–303.

Singer R. 1947. The Boletoideae of Florida, the Boletineae of Florida with notes on extralimital species III. *The American Midland Naturalist* **37**: 1–135.

Singer R. 1962. *The Agaricales in Modern Taxonomy*. 2nd ed. Weinheim: J. Cramer. 915 pp.

Singer R. 1975. *The Agaricalse in Modern Taxonomy*. 3rd ed. Vadulz: J. Cramer. 912 pp.

Singer R. 1986. *The Agaricales in Modern Taxononmy*. 4th ed. Koenigstein: Koeltz Scientific Books. 981 pp.

Smith AH, Thiers HD. 1964. *A Contribution towards a Monograph of North American*

Species of Suillus. Ann Arbor: University of Michigan. 116 pp.

Smith AH, Thiers HD. 1971. *The Boletes of Michigan*. Ann Arbor: the University of Michigan Press. 428 pp.

Smith SE, Read DJ. 1997. *Mycorrhizal Symbiosis*. 2nd Edition. London: Academic Press. 605 pp.

Snell WH, Dick EA. 1941. Notes on Boletes. VI. *Mycologia* **33**: 23–37.

Teng S-C. 1963. *Fungi of China*. Beijing: Sciences Press. 808 pp. (in Chinese).

Yuan M-S, & Sun P-Q. 1995. *Sichuan Mushrooms*. Chengdu: Sichuan Science and Technology Press. 737. (in Chinese).

Zang M. 1980. Some new species of Basidiomycetes from the Xizang Autonomous Region of China. *Acta Microbiologica Sinica* **20**: 29–34. (in Chinese).

Zang M. 1999. An annotated check-list of the genus *Boletus* and its sections from China. *Fungal Science*. **14:** 79–87.

Zang M, Yuan M-S, Gong M-Q. 1993. Notes and additions to Chinese members of the *Boletales*. *Acta Mycologica Sinica* **12**: 275–282. (in Chinese).

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Pluteus thomsonii (Pluteaceae): A northern agaric found in South America

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Abstract—*Pluteus thomsonii (Pluteaceae),* a widespread agaric in the Northern Hemisphere (Europe, North America and Asia), is reported for the first time in South America, in southern Brazil. Full description and line drawings of this species are presented.

Key words—*Agaricales, Pluteus* Sect. *Celluloderma*, Brazilian mycobiota

Introduction

The genus *Pluteus* Fr. *(Pluteaceae, Agaricales)* is macroscopically characterized by basidiomata with free lamellae, a pinkish spore print and the absence of both annulus and volva; microscopically, it is defined by the presence of an inverse hymenophoral trama, stramineous spores, and the presence of hymenial cystidia (metuloidal or not); furthermore, it has a lignicolous habit (Singer 1986). Currently the genus comprises 300 species (Kirk et al. 2001) but only 35 *Pluteus* taxa are recognized from Brazil (Wartchow et al., ined.), most of them recorded by Singer (1953, 1956, 1958, 1961, 1989), and recently by Stijve & de Meijer (1993) and Pegler (1997). In several papers by Rick, summarized in Rick (1961), he reported and described several *Pluteus* species, but many were revised by Singer (1953, 1956) and synonymized with other taxa or considered *nomen dubium* because the lack of type material. This paper reports a *Pluteus* species previously unrecorded from Brazil. Our goal is to obtain a better understanding of the diversity within this genus in the state of Rio Grande do Sul, in southern Brazil.

Materials and methods

The species was collected at the "Morro do Elefante", in Santa Maria, state of Rio Grande do Sul, in southern Brazil. The locality of "Morro do Elefante" comprises subtropical rain forests, with the following species being most abundant: *Allophylus edulis* (St. Hill.) Radlk., *Cupania vernalis* Camb., *Enterolobium contortisiliquum* (Vell.) Morong, *Nectandra megapotamica* (Spreng.) Mez, and *Trichilia claussenii* C.DC. (Machado & Longhi 1990). The methodology of Singer (1986) was followed, and the microscopic line drawings were prepared using a camera lucida. Generic and infra-generic concepts follow Singer (1986). Material is preserved at the Herbarium of the Department of Biology of the Universidade Federal de Santa Maria (SMDB).

Taxonomic Description

Pluteus thomsonii (Berk. & Broome) Dennis, Trans. Br. Mycol. Soc. 31: 206, 1948.
FIGURES **1-6**

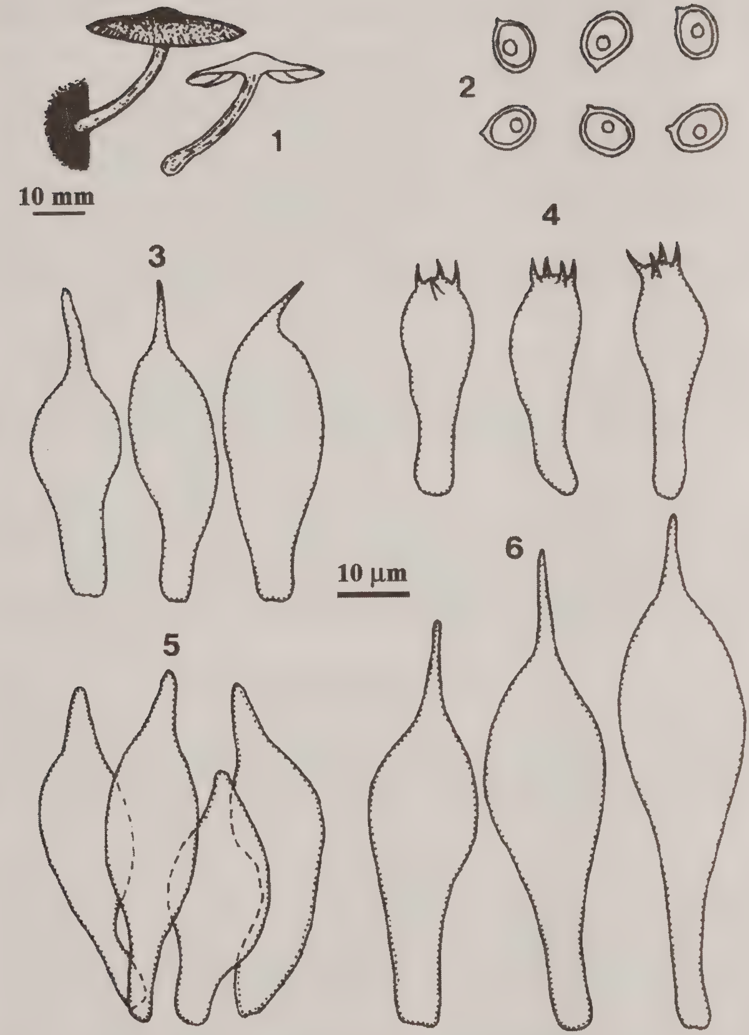
≡ *Agaricus thomsonii* Berk. & Broome, Ann. Mag. Nat. Hist., Ser. IV, 17: 131, 1876.
= *P. cinereus* Quél., Ann. Sci. Nat. Bord. (Suppl.) 14: 3, 1884.
≡ *Entoloma thomsonii* (Berk. & Broome) Sacc., Syll. Fung. 5: 693, 1887.
= *P. reisneri* Velen., Ceské Houby: 610, 1921.
= *P. pilatii* Velen., Mykologia 6: 25, 1929 (as *P. pilati*).
= *P. cinereus* Quél. f. *evenosus* Kühner, Bull, Soc. Mycol. Fr. 72: 181, 1956.
= *P. cinereus* Quél. f. *typicus* Kühner, Bull. Soc. Mycol. Fr. 72: 199, 1956.
≡ *P. thomsonii* f. *evenosus* (Kühner) Wuilb., Misc. Mycol. 15: 16, 1986.

Pileus 36 mm in diam., umbonate to applanate, blackish-grey at the umbo, castaneous-whitish toward the margin, surface radially rugose to slightly venulose on disc, but without a strong venation. **Lamellae** free, pink-colored, abundant. **Stipe** 32 x 3 mm, central, cylindrical, with a slightly expanded base, whitish, longitudinally striate, fibrous, without any kind of velar remnants. **Context** thin, membranous, whitish. **Spore print** pink. **Spores** 6-8 x 4-6.5 µm, subglobose to short ellipsoid in shape, stramineous under light microscope (in KOH), smooth and thick-walled, apiculus evident. **Basidia** 24-33 x 7.5-10.5 µm, thin-walled, clavate, with four sterigmata. **Pleurocystidia** 41.5-76 x 12-23 µm, fusiform, with a long and acute apex, hyaline, abundant. **Cheilocystidia** 32-46 x 9-17.5 µm, similar to the pleurocystidia in shape (fusiform) but smaller in size. **Pileipellis** hymeniform, with cells 29.5-57 x 8-18.5 µm, comprising vesiculose to clavate elements mixed with fusiform to ventricose cystidioid hyphae with an acute apex; brownish pigments uniformly distributed on the cell wall. **Caulocystidia** not seen. **Clamp connections** not observed. **Hymenophoral trama** inverse, with hyaline, thin-walled hyphae.

Habit and habitat: solitary, on decayed wood of unidentified angiosperm, in a subtropical rain forest.

> **Material examined – BRAZIL. Rio Grande do Sul: Santa Maria**, Camobi, Morro do Elefante, 15.X.2001. *Wartchow* (SMDB 9194).

Distribution: Widespread in Europe (Breitenbach & Kränzlin 1995; Citérin & Eyssartier 1998; Consiglio 2000; Dennis 1948; Enderle 1986; Kühner & Romagnesi 1956; Moser 1978; Orton 1960, 1986; Vellinga 1990; Vellinga & Schreurs 1985; Wuilbaut 1986) and North America (Homola 1972; Rodríguez & Guzmán-Dávalos 1999, 2000, 2001), with sporadic records from Asia (Imazeki et al. 1988) and North Africa (Vellinga 1990).


1
2
10 mm
3
4
10 µm
5
6

Figures 1-6. *Pluteus thomsonii*: 1) Basidiome and section. 2) Spores. 3) Cheilocystidia. 4) Basidia. 5) Pileipellis elements. 6) Pleurocystidia.

Remarks: *Pluteus thomsonii* belongs to Section *Celluloderma* Fayod, Subsection *Mixtini* Singer, due to the presence of dimorphic (fusiform and vesiculose) elements on the hymeniform pileipellis (Singer 1986). This species, in its typical form, is characterized by the strong venation of the pileus surface, the size of the spores, and especially by the shape of the cystidia (Consiglio 2000).

Some specimens without a distinctly venose pileus have been called *P. thomsonii* f. *evenosus* (Kühner) Wuilb., as indicated by Wuilbaut (1986), Citérin & Eyssartier (1998) and Consiglio (2000). Our collection agrees very well with the descriptions given by these authors because of the absence of conspicuous veins on the pileus surface. Nevertheless, Orton (1986) established that the presence or absence of veins on the pileus lacks taxonomic value because young basidiomata present a reduced or absent venation, which is very conspicuous in the mature ones. Thus, the above-cited forms are currently considered synonyms by these and other modern authors (e.g., Vellinga 1990; Rodríguez & Guzmán-Dávalos 1999), and this taxonomic treatment is herein applied.

This species is somewhat similar to other taxa of Section *Celluloderma*, such as *P. insidiosus* Vellinga & Schreurs, a European species which has only vesiculose elements on pileipellis (Subsection *Eucellulodermini* Singer) instead of *P. thomsonii* which has dimorphic elements on it (Rodríguez & Guzmán-Dávalos 1999).

Singer (1953, 1956, 1958, 1961, 1969, 1989) studied many *Pluteus* collections from South America, including Brazil, but does not refer to *P. thomsonii* or its synonyms. Other authors as like Courtecuisse (1991), Dennis (1953, 1970), Horak (1964, 1979), Pegler (1997), Singer & Digilio (1951), and Stijve & de Meijer (1993), in their studies of *Pluteus* in South America, also do not cited this species. This is the first record of *P. thomsonii* from South America and Brazil.

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Literature cited

Breitenbach J, Kränzlin F. 1995. Champignons de Suisse. Tome IV. Pars 2: *Agaricaceae, Amanitaceae, Entolomataceae, Pluteaceae, Coprinaceae, Bolbitiaceae* et *Strophariaceae*. Lucerne: Mykologia Lucerne.

Citérin M, Eyssartier G. 1998. Clé analytique du genre *Pluteus* Fr. Doc. Mycol. 28 (111): 47-67.

Consiglio G. 2000. Contributo alla conoscenza del genere *Pluteus* - II. Boll. Circ. Micol. G. Carini 40: 15-36.

Courtecuisse R. 1991. Eléments pour un inventaire mycologique des environs du saut Pararé (Arataye) et de l'inselberg des Nouragues (Guyane française). V. *Pluteaceae (Pluteales,* Basidiomycota). Crypt. Bot. 2/3: 136-152.

Dennis RWG. 1948. Some little known British species of *Agaricaceae*. I. Leucosporae and Rhodosporae. Trans. Br. Mycol. Soc. 31: 191-209.

Dennis RWG. 1953. Les *Agaricales* de l'Ile de La Trinité: *Rhodosporae-Ochrosporae*. Bull. Soc. Mycol. Fr. 69: 147-198.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3. London: HMSO.

Enderle M. 1986. *Pluteus* –-funde in hiesigen Auwäldern. Ulmer Pilzflora 1: 9-78.

Homola R. 1972. Section *Celluloderma* of the genus *Pluteus* in North America. Mycologia 64: 1211-1247.

Horak E. 1964. Fungi Austroamericani II. *Pluteus* Fr. Nova Hedwigia 8: 163-199 + 20 pl.

Horak E. 1979. Fungi: Basidiomycetes *Agaricales* y Gasteromycetes Secotioides. Flora Criptogámica de la Tierra del Fuego 9, Buenos Aires.

Imazeki R, Otani Y, Hongo T. 1988. Fungi of Japan. Tokyo: Yama-Key Publ. [In Japanese].

Kirk PM, Cannon PF, David JC, Stalpers JA. (eds.). 2001. Ainsworth & Bisby's dictionary of fungi. 9ed. Surrey : CABI/International Mycological Institute.

Kühner R, Romagnesi H. 1956. Compléments à la Flore Analytique. VIII. Espéces nouvelles ou rares de Volvariacées. Bull. Soc. Mycol. Fr. 72: 181-249.

Machado PF, Longhi SJ. 1990. Aspectos florísticos e fitossociológicos do "Morro do Elefante", Santa Maria, RS. Rev. Centro de Ciências Rurais 20: 261-280.

Moser M. 1978. Die Rörhlinge und Blätterpilze *(Polyporales, Boletales, Agaricales, Russulales)*. 4. Anfl. Stuttgart: Gustav Fischer Verlag.

Orton PD. 1960. New checklist of British Agarics and Boleti. III. Notes on genera and species in the list. Trans. Br. Mycol. Soc. 43: 159-439.

Orton PD. 1986. British fungus flora 4: Pluteaceae: *Pluteus* & *Volvariella*. Edinburgh: HMSO.

Pegler DN. 1997. The agarics of São Paulo, Brazil. London: HMSO.

Rick J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul – Brasília 5. Agaricaceae. Iheringia, Ser. Bot. 8: 296-450.

Rodríguez O, Guzmán-Dávalos L. 1999. Nuevos registros del género *Pluteus* Fr. (Pluteaceae) en México. Doc. Mycol. 29 (114): 67-78.

Rodríguez O, Guzmán-Dávalos L. 2000. Algunas especies del género *Pluteus* Fr. (Pluteaceae, Agaricales) citadas en Nueva Galicia, México. Bol. Inst. Bot. Univ. Guadalajara 7: 61-77.

Rodríguez O, Guzmán-Dávalos L. 2001. Clave dicotómica de las especies del género *Pluteus* Fr. (Pluteaceae) conocidas de la región de Nueva Galicia y algunas áreas aledañas, México. Acta Bot. Mex. 57: 23-36.

Singer R. 1953. Type studies on Basidiomycetes IV. Lilloa 26: 57-159.

Singer R. 1956. Contributions toward a monograph of the genus *Pluteus*. Trans. Br. Mycol. Soc. 39: 145-232.

Singer R. 1958. Monographs of South American Basidiomycetes especially those of the east slope of the Andes and Brazil. I. The genus *Pluteus* in South America. Lloydia 21: 195-299.

Singer R. 1961. Monographs of South American Basidiomycetes especially those of the east slope of the Andes and Brazil. IV. *Inocybe* in Amazone region and a supplement to part I. *Pluteus* in South America. Sydowia 15: 112-132.

Singer R. 1969. Mycoflora Australis. Beih. Nova Hedwigia 29: 1-405.

Singer R. 1986. The *Agaricales* in modern taxonomy. 4 ed. Koeningstein: Koeltz Scientific Books.

Singer R. 1989. New taxa and new combinations in the *Agaricales* (Diagnoses Fungorum Novorum Agaricalium IV). Fieldiana Bot. 21: 1-133.

Singer R, Digilio APL. 1951. Pródromo de la Flora Agaricina Argentina. Lilloa 25: 5-462.

Stijve T, de Meijer AAR. 1993. Macromycetes from the state of Paraná, Brazil. 4. The psychoactive species. Arq. Biol. Tecnol. 36: 313-329.

Vellinga EC. 1990. *Pluteus*. Pp. 31-55. In: Bas C, Kuyper TW, Noordeloos ME, Vellinga EC. (eds.). Flora Agaricina Neerlandica. Vol. 2. Rotterdam: Balkema.

Vellinga EC, Schreurs J. 1985. Notulae ad floram agaricinam Neerlandicam - VIII. *Pluteus* Fr. in West-Europe. Persoonia 12: 337-373.

Wuilbaut JJ. 1986. Description de *Pluteus thomsonii* (B. & Br.) Dennis fo. *evenosus* (Kühn.) Wuilbaut comb. nov. Miscell. Mycol. 15: 14-16.

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The *Stropharioideae (Strophariaceae, Agaricales)* from Santa Maria, Rio Grande do Sul, Brazil

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Abstract–Collections of *Hypholoma subviride, Melanotus proteus, Psilocybe caeruleoannulata, P. coprophila, P. cubensis, P. moellerii, P. pegleriana, Stropharia coronilla, S. rugosoannulata,* and *S. semiglobata,* all placed in subfamily *Stropharioideae (Strophariaceae, Agaricales)* are discussed and illustrated from southern Brazil. *Melanotus proteus, P. moellerii* and *P. pegleriana* are recorded for the first time from the country, and *S. rugosoannulata* and *H. subviride* collections represent new records for the state of Rio Grande do Sul.

Key words – Basidiomycetes, tropical agarics, Brazilian mycobiota

Introduction

Little is known about members of the family Strophariaceae Singer & A.H. Sm. in Brazil. Guzmán (1978) and Guzmán et al. (1984), who described new *Psilocybe* taxa, and Pegler (1997) have contributed the most significant modern records of these fungi in Brazil. Stijve & de Meijer (1993), who studied psychoactive agarics from the state of Paraná, recorded several *Psilocybe* and some *Stropharia* species. Guzmán et al. (2000) included 18 neurotropic species of *Psilocybe* from Brazil on their checklist of world psychotropic fungi, and regional checklists by Bononi et al. (1984), Sotão et al. (1991), and Vinha (1988) cited a few species of *Strophariaceae (Stropharioideae)* from some Brazilian states.

Rick (1907, 1930, 1939, 1961), who provided the earliest and possibly only records of Strophariaceae from Rio Grande do Sul, cited 9 *Stropharia*, 10 *Hypholoma*, and 5 *Psilocybe* species, including the new taxa, *S. subcyanescens* Rick and *S. siccipes* P. Karst. var. *lugubris* Rick. Singer (1953) revised several Rick's types and collections, and reported other taxa.

The goal of our current taxonomic survey is to expand what is known about the Strophariaceae from the Rio Grande do Sul state, in southern Brazil. The current paper focuses on the subfamily Stropharioideae (Singer) Singer in the sense of Singer (1986), although several taxonomic concepts about the family Strophariaceae have been recently arisen (e.g., Kühner 1984; Noordeloos 1999; Smith 1979; Watling & Gregory 1987).

Materials and methods

Collections were made from March 2001 to March from within Santa Maria between 53°30'22"- 54°19'32" W, and 29°20'28" - 30°00'16" S, within the Depressão Central of Rio Grande do Sul state. The area encompasses two main vegetation types (Pereira et al. 1989); subtropical forests to the northeastern and meadows to the southwestern. The subtropical forests contain trees belonging to the Fabaceae, Lauraceae, Myrtaceae, Meliaceae, and Sapindaceae (Longhi et al. 2000; Machado & Longhi 1990). The meadows are dominated by species of Poaceae, Fabaceae, Asteraceae, Rubiaceae, and Cyperaceae (Quadros et al. 2003).

Tissues of collected specimens were mounted in 5% KOH and 10 % NH_4OH aqueous solutions. Basidiospore colors in descriptions are indicated under KOH observations. Vouchers of all studied collections are deposited at the Herbarium of the Department of Biology of the Universidade Federal de Santa Maria (SMDB). Exsiccati from PACA (Herbarium Anchieta, UNISINOS) and ICN (Department of Botany, Universidade Federal do Rio Grande do Sul) were also examined.

Results

Ten species representing the genera *Hypholoma* (1), *Melanotus* (1), *Psilocybe* (5), and *Stropharia* (3) were identified.

Key to the species of subfamily *Stropharioideae* of Santa Maria

1a. Chrysocystidia present. Spore print dark vinaceous brown **2**
1b. Chrysocystidia absent. Spore print violaceous black................................ **5**

2a. Lignicolous, cespitose. Pileus sulfur yellow, ≤35 mm diam. Annulus absent. Basidiospores 5-9 µm long (genus *Hypholoma*) .... **1. *H. subviride***
2b. Coprophilous or terrestrial, solitary to gregarious (genus *Stropharia*) **3**

3a. Coprophilous. Basidiospores ≥16 µm long .... **10. *S. semiglobata***
3b. Terrestrial. Basidiospores ≤16 µm long **4**

4a. In meadows. Pileus ≤ 60 mm diam., yellowish. Basidiospores 6-10 µm long. Cheilocystidia clavate .... **8. *S. coronilla***
4b. In forests. Pileus ≥ 60 mm diam., vinaceous. Basidiospores 9-14µm long. Cheilocystidia fusoid-ventricose .... **9. *S. rugosoannulata***

5a. Habit pleurotoid, on coniferous wood. Stipe reduced. Basidiospores 5-7 µm long, subhexagonal in face view (genus *Melanotus*) .... **2. *M. proteus***
5b. Habit never pleurotoid. Stipe well developed (genus *Psilocybe*) **6**

6a. Annulus absent. Pileus reddish brown, strongly hygrophanous. Basidiospores 10-12 µm. On dung .... **4. *P. coprophila***
6b. Annulus or velar remnants present on stipe. Pileus yellowish to brownish **7**

7a. Specimen not bluing on stipe **8**
7b. Specimen bluing on stipe **9**

8a. Annulus submembranous. Basidiospores 9-11 µm long ... **7. *P. pegleriana***
8b. Annulus fibrillose, not membranous. Basidiospores 12-14 µm long .... **6. *P. moellerii***

9. Basidiomata ≤ 50 mm. Basidiospores 9-12 µm long, ovoid in face view .... **3. *P. caeruleoannulata***
9b. Basidiomata usually ≥ 50 mm. Basidiospores 12-17µm long, subhexagonal in face view .... **5. *P. cubensis***

HYPHOLOMA (FR.) P. KUMM.

1. *Hypholoma subviride* (Berk. & M.A. Curtis) Dennis, Kew Bull. 15: 134, 1961. FIGURE 1 A-D

Pileus 8-35 mm diam., conic, becoming plano-convex; surface dry, smooth; color sulfur-yellow, darker on central disc; margin non-striate, brownish, without velar remnants; context thin, fleshy, yellow. **Lamellae** adnate, initially sulfur-yellow colored, becoming vinaceous brown in age. **Stipe** 25-66 x 1.5-4 mm, central, cylindrical, sometimes sinuous, concolorous with the pileus. **Veil** never forming an annulus.

Basidiospores dark vinaceous brown in mass; 5.5-9 x 3-5 μm, ellipsoid both in face and side view, apically truncated by a broad germ pore; smooth, thick-walled, yellowish brown. **Basidia** 16-22.5 x 4.5-7 μm, clavate, tetrasporic. **Pleurocystidia** 19-38.5 x 5.5-9.5 μm, as true chrysocystidia; fusoid, mucronate, with amorphous content. **Cheilocystidia** not observed. **Pileipellis** composed of prostrate, thick walled hyphae. **Hypodermium** subcellular, with inflated hyphae. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Lignicolous on decomposed wood, particularly *Eucalyptus*.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** Campus UFSM, 20.VIII.2000 *Cortez* 041/00 (SMDB 9226); Morro do Elefante, 9.V.2001 *Cortez* 024/01 (SMDB 9244), 21.VII.2001 *Wartchow* 007 (SMDB 9190).

Distribution: North America (Smith 1951); Central America (Pegler 1983, 1988); South America (Dennis 1970; Pulido 1983); Africa (Pegler 1977; Reid & Eicker 1999); Europe (Krieglsteiner & Enderle 1986); Asia (Pegler 1986).

Remarks: Previously reported from Brazilian states of Amapá (Sotão et al. 1991) and São Paulo (Bononi et al. 1984; Pegler 1997), this is the first record of *H. subviride* from the Rio Grande do Sul state. Dennis (1970) interpreted this species as a reduced tropical form of the temperate *H. fasciculare* (Huds.: Fr.) P. Kumm., reported from Rio Grande do Sul by Rick (1961). Krieglsteiner & Enderle (1986) considered *H. subviride* as a variety of that species. Smith (1951) separated the two species based on differences in geographic distribution and in some secondary characters (e.g., for *H. fasciculare* a pileus size > 30 mm and convex shape).

Other *Hypholoma* species – Rick (1961) reported *Hypholoma ericaeum* (Pers.: Fr.) Kühner (*Rick 14.554*, PACA, as *Psilocybe ericacea* Pers.) from Santa Maria. We have not examined Rick's collection or gathered any fresh specimens during our study.

MELANOTUS PAT.

2. *Melanotus proteus* (Kalchbr.) Singer, Lloydia 9: 130, 1946. FIGURE 2 A-E

Pileus 2-12 mm diam., reniform, convex; surface dry to moist, glabrous; pale brown, opaque; margin incurved, non-striate; velar remnants absent; context thin, whitish. **Lamellae** adnate to subdecurrent; pale fuscous brown. **Stipe** 1-2 x –1 mm, lateral, cylindrical, very reduced; brown with abundant white mycelium at the base. **Veil** absent.

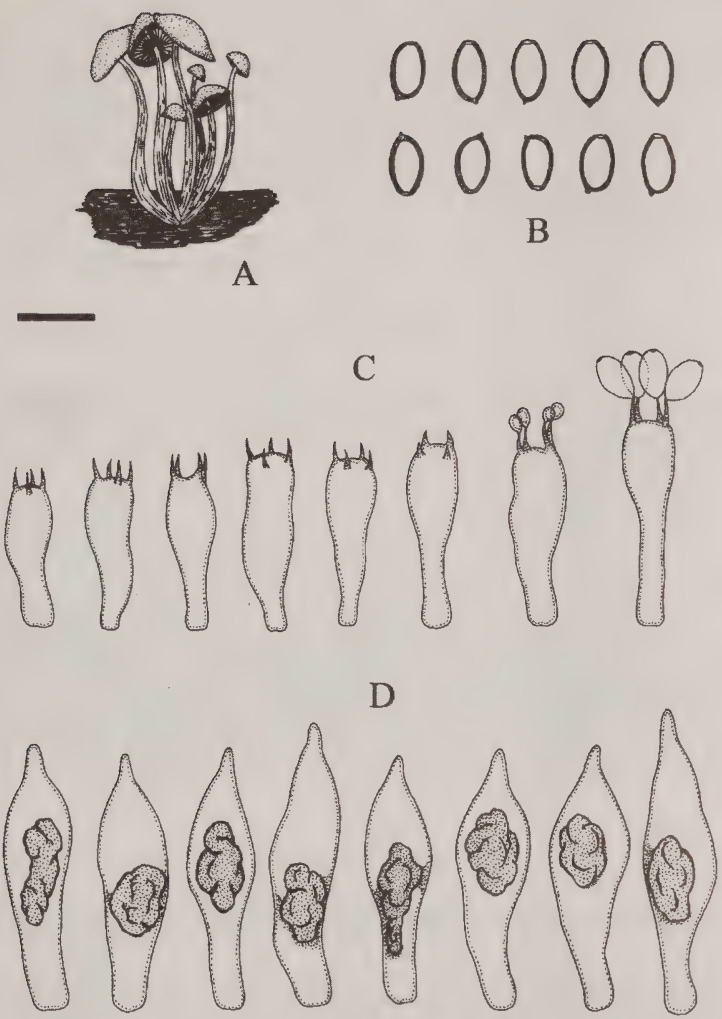

Figure 1. ***Hypholoma subviride*****:** A. Basidiomata. B. Basidiospores. C. Basidia. D. Chrysocystidia. Scale bar: A = 20 mm; B-D = 10μm.

Basidiospores violaceous brown as noted on stipe and pileus surfaces; 4.5-7 x 3-5 μm, broad ellipsoid to subhexagonal both in face and side view, apically truncated by a broad germ pore, smooth and thick-walled, brown. **Basidia** 13-21.5 x 5-7 μm, clavate, tetrasporic. **Pleurocystidia** absent. **Cheilocystidia** 14.5-25 x 4-6.5 μm, lageniform to subcapitate, long-necked, hyaline, thin-walled. **Pileipellis** an ixocutis composed by prostrate, clamped, 5-8 μm wide hyphae, walls somewhat thickened and incrusted. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Lignicolous on fallen branches of *Araucaria angustifolia* (Bertol.) O. Ktze.

Specimens examined: BRAZIL. Rio Grande do Sul: **Itaara,** Parque Pinhal, 23.II.2002 *Cortez* 008/02 (SMDB).

Distribution: Europe (Bon & Pacaud 2002; Kits Van Waveren 1979; Redfern 1991; Vesterholt 1993; Watling & Gregory 1987); Asia (Pegler 1986); Africa (Horak 1977; Pegler 1977).

Remarks: Mating studies by Sime & Petersen (1999) have suggested that *M. proteus* and *M. textilis* Redhead & Kroeger are both synonyms of *M. horizontalis* (Bull.: Fr.) P.D. Orton. Watling & Gregory (1987) separated *M. proteus* by the coniferous substrate, pale velutinate pileus, and ellipsoid-amygdaliform spores, and their concept is here followed. *Melanotus proteus* is known to be a potential competitor of *Heterobasidium annosum* (Fr.) Bref., a polypore which causes root and heart-rot in coniferous trees in Europe (Redfern 1991), and has been studied as a biological controller of this wood-pathogen (Pratt & Quill 1996). This *Melanotus* is recorded for the first time in Brazil.

PSILOCYBE (FR.) P. KUMM.

3. ***Psilocybe caeruleoannulata*** Singer ex Guzmán, Mycotaxon 7: 235, 1978.

FIGURE 2 F-I

Pileus 10-50 mm diam., conic to convex, surface subviscid, smooth; brownish with striate margin; context fleshy, pale brownish, probably bluing. **Lamellae** adnexed, blackish brown, rather close. **Stipe** 30-40 x 5 mm, central, cylindrical, flexuous, annulate. **Veil** present as a membranous annulus, bluing.

Basidiospores violaceous brown in mass; 9.5-12 x 6.5-7 μm, subellipsoid in side view and ovoid in frontal view, smooth and thick-walled, germ-pore broad, brownish. **Basidia** 17.5-21 x 5.5-7 μm, clavate, tetrasporic.

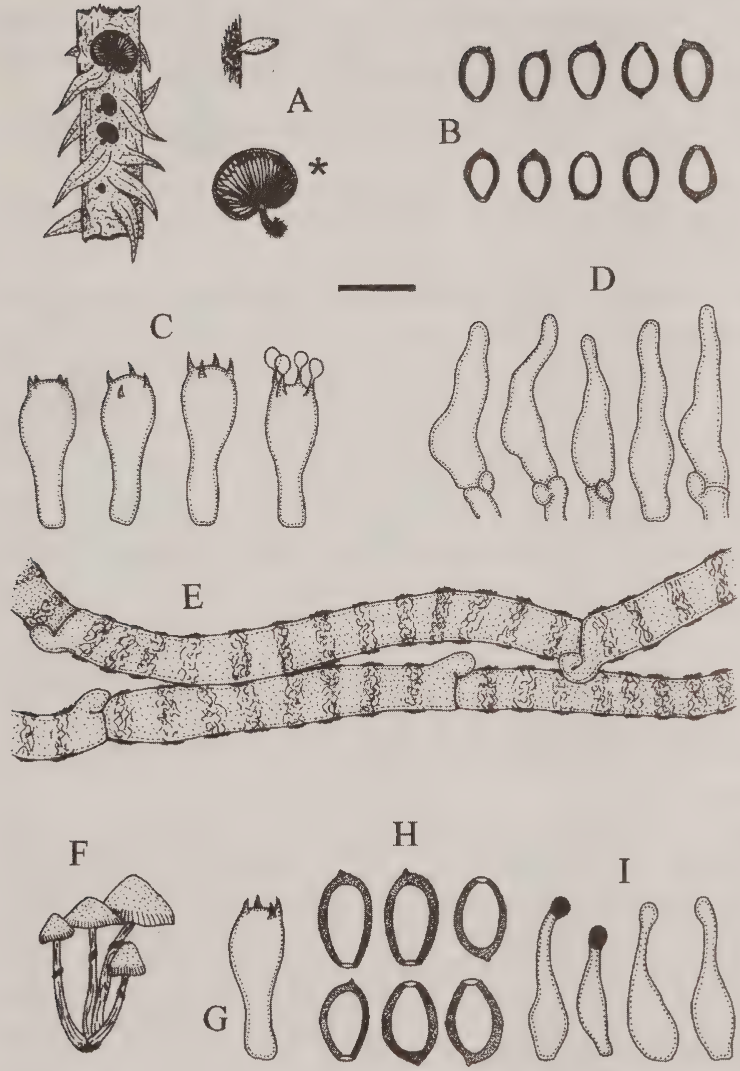

Figure 2. A-E: ***Melanotus proteus*****:** A. Basidiomata. B. Basidiospores. C. Basidia. D. Cheilocystidia. E. Pileipellis. **F-I:** ***Psilocybe caeruleoannulata*****:** F. Basidiomata. G. Basidium. H. Basidiospores. I. Cheilocystidia. Scale bar: A*= 40 mm; A, F = 20 mm; B-E, G-I = 10 μm.

Pleurocystidia absent. **Cheilocystidia** 15.5-21.5 x 3-6.5 μm, ventricose, with a long neck, subcapitate, thin-walled, sometimes with an oleous incrustation at the apex. **Pileipellis** an ixocutis, with hyaline to slightly incrusted hyphae. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Lignicolous, cespitose on rotting woodchips of *Araucaria angustifolia* or *Podocarpus*.

Specimens **examined:** BRAZIL. Rio Grande do Sul: **Santa Maria,** 1936, *Rick* 15.234 (PACA 9370, holotype of *Stropharia siccipes* var. *lugubris*), *Rick* 15.237 (PACA 9371), *Rick* 15.238 (PACA 9372).

Distribution: South America (southern Brazil and Uruguay - Guzmán 1983).

Remarks: No fresh specimens of this species were collected in our study, and the collections studied are not in good condition. The macroscopic description above is based on observations by Rick (1961), who first described the species as *Stropharia siccipes* P. Karst. var. *lugubris* Rick (Rick 1939). Guzmán (1978) studied the type and considered it as a synonym of *P. caeruleoannulata*. This is a bluing species, probably with psychotropic effects, as supported by the chemical analysis performed by Stijve & de Meijer (1993). It belongs to the Section *Stuntzae* Guzmán and is most closely related to *P. uruguayensis* Singer ex Guzmán and *P. stuntzii* Guzmán & Ott, two closest species. Stijve & de Meijer (1993) also suggested that *P. caeruleoannulata* and *P. uruguayensis* represent a single South American endemic species. *Psilocybe caeruleoannulata* has been also reported from the states of Paraná (Stijve & de Meijer 1993) and São Paulo (Pegler 1997).

4. *Psilocybe coprophila* (Bull.: Fr.) P. Kumm., Führ. Pilzk.: 71, 1871.

Figure 3 A-E

Pileus 4-14 mm diam., convex to campanulate or applanate-umbonate; surface subviscid, glabrous, smooth; margin striate, frequently with appendiculate whitish velar remnants; color dark reddish brown to orange brown, finally pale yellowish, strongly hygrophanous; context thin, whitish. **Lamellae** adnate to subdecurrent, brownish to violaceous in age, with a whitish edge. **Stipe** (6) 11-36 x 1-2.5 mm, central, cylindrical, hollow, basal surface with little squamules; pale to dark brown, never bluing. **Veil** fugacious, present as fibrillose remnants on pileus margin, not forming an annulus.

Basidiospores violaceous brown to violaceous black in mass; 11-14.5 x 7-9.5 μm, subellipsoid in side view and subhexagonal in frontal view; smooth and thick-walled, with a well developed germ pore, yellowish brown.

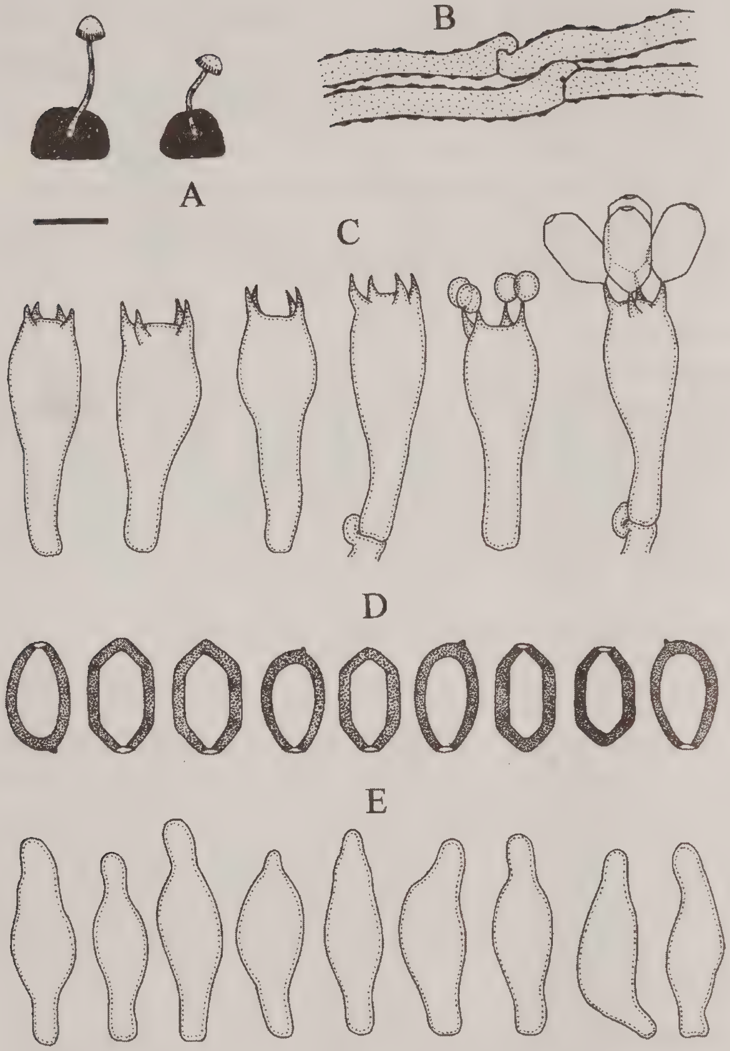

Figure 3. ***Psilocybe coprophila*****:** A. Basidiomata. B. Hyphae of the hypodermium. C. Basidia. D. Basidiospores. E. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10 □m.

Basidia 25-36 x 9-13.5 μm, hyaline, subclavate, tetrasporic. **Pleurocystidia** absent or if present as like the cheilocystidia. **Cheilocystidia** 19-37 x 6.5-9.5 μm, lageniform, with a short to long neck, hyaline, thin-walled, forming a sterile zone in the gill margin. **Pileipellis** an ixocutis composed by prostrate hyphae. **Hypodermium** formed by hyphae encrusted with golden yellowish pigment. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Coprophilous, gregarious on cow and horse dung, in meadows.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** UFSM Expositions Park, 7.XI.2000 *Cortez* 051/00 (SMDB 9227); 21.VI.2001 *Cortez* 036/01 (SMDB); **Nova Petrópolis,** V.1992 *RT Guerrero* (ICN 95509, as *Stropharia semiglobata*).

Distribution: Worldwide (Guzmán 1983).

Remarks: *Psilocybe coprophila* is a very common, widespread and non-hallucinogenic species (Guzmán 1983; Stijve & de Meijer 1993). Basidiospore morphology separates it from the macroscopically similar *P. subcoprophila* (Britz.) Sacc. (unknown in Brazil), which is characterized by larger (15-19 μm long) ellipsoid in both side and frontal view (Noordeloos, 1998). In Brazil, *P. coprophila* was previously recorded from the states of São Paulo (Guzmán 1983), Paraná (Stijve & de Meijer 1993), and Rio Grande do Sul (Rick 1961).

5. *Psilocybe cubensis* (Earle) Singer, Sydowia 2: 37, 1948. FIGURE 4 A-E

Pileus 26-85 mm diam., conic to campanulate, becoming convex or applanate but sub-umbonate with the age; surface subviscid, smooth or with small whitish or yellowish scales; color orange brown on the center and pale yellow toward the margin, bluing with the age; margin slightly striate, sometimes with membranous velar remnants appendiculate; context fleshy, whitish, but becoming blue when cut. **Lamellae** adnexed to adnate, grayish to violaceous brown with the maturity of the spores; edges whitish. **Stipe** 47-112 x 5-14 mm, central, cylindrical to sub-bulbous; white to cream color, changing to blue when touched or cut, surface striate near the pileus and with white to bluish squamules bellow the annulus. **Veil** forming a membranous, well developed white annulus.

Basidiospores deep violaceous brown in mass; 12-17.5 x 7-11 μm, subellipsoid in side view and subhexagonal in face view; smooth and thick-walled, truncated, with a wide germ-pore; yellowish brown. **Basidia** 21.5-27 x 8-13 μm, tetrasporic, subclavate to ventricose, with a medial constriction.

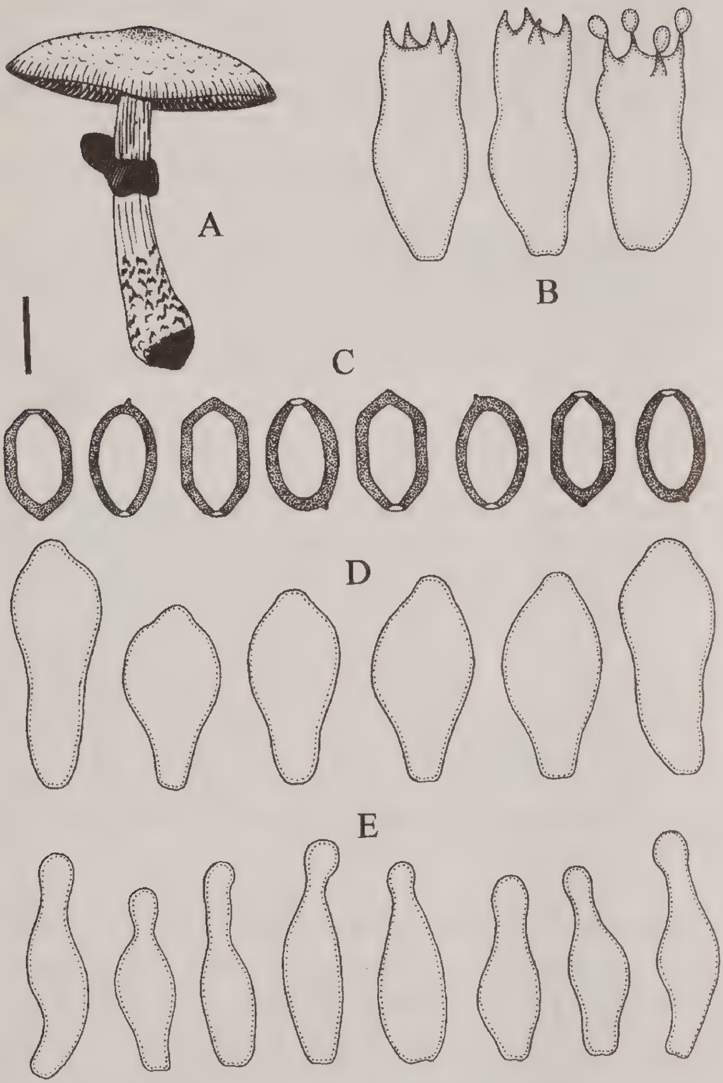

Figure 4. ***Psilocybe cubensis*:** A. Basidiome. B. Basidia. C. Basidiospores. D. Pleurocystidia. E. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10 μm.

Pleurocystidia 21.5-32 x 7-13μm, utriform to subpiriform, hyaline, rare. **Cheilocystidia** 20-32 x 5.5-10.5 μm, lageniform to subcapitate, hyaline, forming a sterile band on the gill edge. **Pileipellis** an ixocutis formed by radially arranged hyphae, gelatinized. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Coprophilous, solitary to gregarious on horse and cow dung, in meadows.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** 1936 *Rick* 15227 (PACA 9376, neotype of *Stropharia subcyanescens* Rick); V.1981 *Flavio* (ICN 6676); Arroio Grande District, 5.II.2001 *Cortez* 003/01 (SMDB 9233); UFSM Expositions Park, 8.XI.2000 *Cortez* 052/00 (SMDB 9228), 10.IV.2001 *Cortez* 015/01 (SMDB 9240), 10.X.2001 *Cortez* 046/01 (SMDB 9259). **Restinga Seca,** 11.V.2001 *Cortez* 029/01 (SMDB 9249). **Vera Cruz,** Linha Um, 1.XII.2001 *Cortez & J Putzke* (SMDB 9265). **Guaíba,** Centro Agronômico, 10.IV.1972 *MH Homrich* (ICN 6351).

Distribution: Pantropical (Guzmán 1983).

Remarks: *Psilocybe cubensis*, one of the most common hallucinogenic mushrooms, is widespread in the tropics (Guzmán 1983). *Psilocybe subcubensis* Guzmán, another species in Section *Cubensae* is very close, but has shorter spores (11-13 μm long – Guzmán 1978). Since the two species are recorded from the same habitats, the occurrence of *P. subcubensis* in Brazil should be suspected. *Psilocybe cubensis* is known from the states of Espírito Santo (Vinha 1988), São Paulo (Guzmán 1978; Pegler 1997), Paraná (Stijve & de Meijer 1993), and Rio Grande do Sul (Guerrero & Homrich 1983, 1999; Rick 1930, 1939, 1961 – as *Stropharia subcyanescens* Rick; Singer 1953). *Agaricus rhytopilus* Mont., described from an undetermined locality in Brazil (possibly central western), corresponds to *P. cubensis* according to Pegler (1989), who studied only the Montagne's illustrations and based his identification on the habit, annulus, and habitat on horse dung.

6. *Psilocybe moellerii* Guzmán, Mycotaxon 7: 245, 1978. FIGURE 5 A-D

Pileus 10 mm diam., convex to hemispheric, surface apparently dry, but possibly subviscid when moist, smooth, color brownish to ochraceous; margin striate, non hygrophanous; context thin, whitish. **Lamellae** adnexed to slightly subdecurrent, violaceous grey, with a whitish edge. **Stipe** 35 x 3 mm, central, cylindrical to slightly expanded at the base, pale brownish; surface striate above the annular zone, but somewhat smooth toward the base. **Veil** forming an annular zone in the upper quarter of the stipe, violaceous due the deposition of the spores.

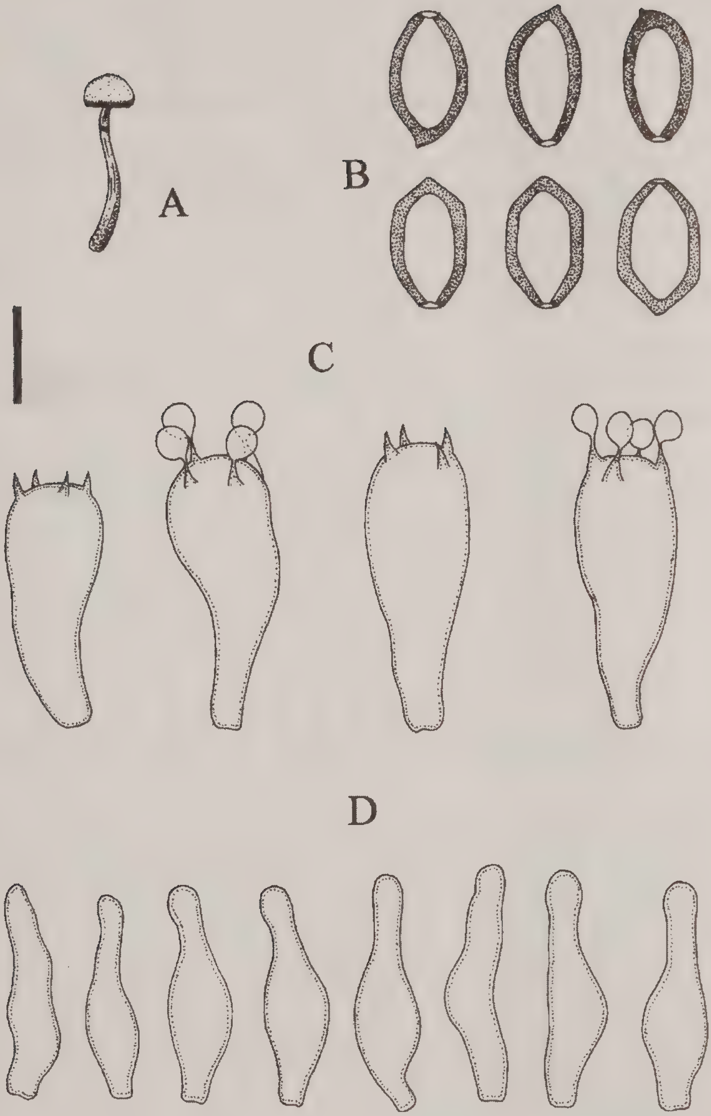

Figure 5. ***Psilocybe moelleri*****:** A. Basidiome. B. Basidiospores. C. Basidia. D. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10 μm.

Basidiospores violaceous in mass, as seen on stipe surface; 10.5-15 x 7-9.5 μm, slightly subhexagonal in frontal view and subellipsoid in side view, smooth and thick-walled, truncated due the presence of a conspicuous germ-pore, yellowish brown. **Basidia** 22.5-31 x 10.5-13.5 μm, hyaline, clavate, tetrasporic. **Pleurocystidia** absent. **Cheilocystidia** 16-26.5 x 4-7 μm, ventricose, lageniform or subcapitate, thin-walled, hyaline. **Pileipellis** an ixocutis formed by thin-walled, parallel hyphae. **Hymenophoral trama** regular, with thin-walled hyphae. **Clamp connections** present.

Ecology: Coprophilous, solitary on cow dung, in pastures.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** Camobi, near the Morro do Elefante, 24.XII.2001 *Cortez* 052/01 (SMDB).

Distribution: Temperate to subtropical Europe (Breitenbach & Kränzlin 1995; Noordeloos 1998, 1999; Watling & Gregory 1987), North and South America (Guzmán 1983; Yokoyama 1987).

Remarks: This uncommon and non-bluing representative of *Psilocybe* Section *Merdariae* (Fr.) Singer, occurs in both temperate and subtropical regions of the world (Guzmán 1983). *Psilocybe moellerii* is close to *P. merdaria* (Fr.) Ricken and *P. merdicola* Huijsman; the former has slightly shorter spores (10-14μm long), and the second has larger (12-18 μm long) oblong spores (Guzmán 1983; Noordeloos 1999). The studied specimen was collected unfortunately in dry conditions, and the macroscopic features are limited. It is the first record of this species from Brazil.

7. *Psilocybe pegleriana* Guzmán, Doc. Mycol. 29: 43, 2000. FIGURE 6 A-E

Pileus 4.5-10 mm diam., hemispheric, umbonate; surface moist, glabrous, hygrophanous; color grayish brown at margin and orange brown at the disc; margin striate; context fleshy, pale brownish, unchanging. **Lamellae** adnate to subdecurrent; brown to violaceous brown. **Stipe** 38-42 x 1.5-3 mm, cylindrical, central, slightly expanded at base; softly grayish, longitudinally striate. **Veil** forming a well developed, membranous, white and persistent annulus, but sometimes vestigial; violaceous at the upper surface due to spore deposition.

Basidiospores violaceous black in mass; 9.5-11 x 7-9.5 μm, subhexagonal in frontal view, ellipsoid in side view; smooth and thick-walled, with a conspicuous germ pore. **Basidia** 19-28 x 7-9.5 μm, clavate, tetrasporic. **Pleurocystidia** absent. **Cheilocystidia** 20-27.5 x 4-8 μm, mainly lageniform, hyaline. **Pileipellis** an ixocutis of hyaline, prostrate hyphae. **Hymenophoral trama** regular. **Clamp connections** present.

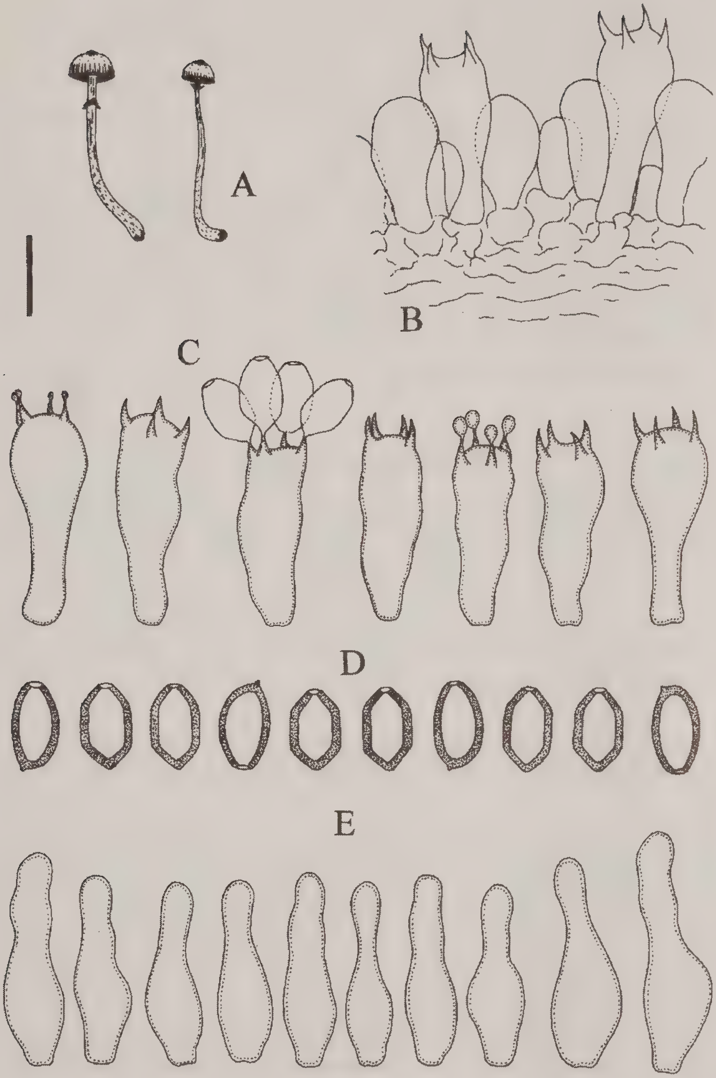

Figure 6. ***Psilocybe pegleriana*:** A. Basidiomata. B. Detail of the hymenium. C. Basidia. D. Basidiospores. E. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10 μm.

Ecology: Coprophilous, gregarious on cow dung, in pastures.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** UFSM Expositions Park, 13.XII.2000 *Cortez* 054/00 (SMDB 9229).

Distribution: North America (Guzmán 2000), South America, Africa (Guzmán 1983, 2000), and Asia (Thomas et al. 2002).

Remarks: *Psilocybe pegleriana* also belongs to Section *Merdariae*. Guzmán (2000) described the species based on collections from Mexico, Venezuela and Africa that he (Guzmán 1983) first considered as *P. pseudobullacea* (Petch) Pegler, following Pegler (1977). However, Pegler (1986) re-described the species after noting the presence of pleurocystidia in the type of *P. pseudobullacea* from Sri Lanka. Our collection of *P. pegleriana* represents a new addition to Brazilian mycobiota.

STROPHARIA (FR.) QUÉL.

8. ***Stropharia coronilla*** (Bull.: Fr.) Quél., Mem. Soc. d'Emul. Mont. Ser. II, 5: 237, 1872. FIGURE 7 A-E

Pileus 20-55 mm diam., hemispheric to plano-convex; surface moist, glabrous; pale yellow in color, margin slightly involute in young basidiomata; context fleshy, whitish, unchanging. **Lamellae** adnexed to adnate, grayish, becoming violaceous to vinaceous brown with whitish edges. **Stipe** 22-47 x 4-8 mm, central, cylindrical to sub-bulbous, solid; somewhat longitudinally striate. **Veil** well developed, forming a membranous to thick and fleshy annulus; white but becoming vinaceous due the deposition of the spores, grooved on upper surface.

Basidiospores dark vinaceous brown in mass; 6.5-10.5 x 5-6.5 μm, ellipsoid both in frontal and side view; smooth and thick-walled, with an absent or inconspicuous germ-pore, brown. **Basidia** 20-29 x 6.5-10 μm, clavate, tetrasporic or occasionally bisporic. **Pleurocystidia** 28-48 x 7-13 μm, clavate to mucronate, as true chrysocystidia, with amorphous contents. **Cheilocystidia** 21.5-56 x 8-13 μm, chrysocistidiod or not, mainly clavate or fusiform, similar to pleurocystidia. **Pileipellis** an ixocutis, composed by filamentous, prostrate, somewhat gelatinized hyphae. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Terrestrial, solitary or gregarious in soil of gardens and fields between grasses.

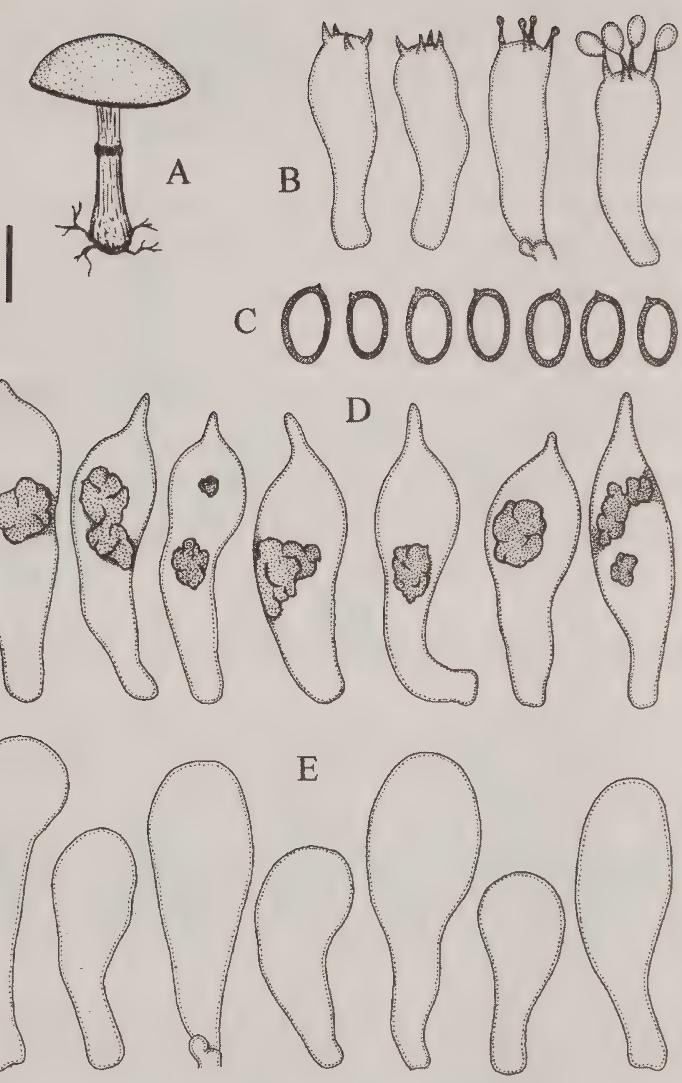

Figure 7. ***Stropharia coronilla*:** A. Basidiome. B. Basidia. C. Basidiospores. D. Chrysocystidia. E. Cheilocystidia. Scale bar: Fig. A = 20 mm; Figs. B-E = 10 μm.

Material examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** Vila Caramelo, 30.IV.2001 *Cortez* 020/01 (SMDB 9242); Passo dos Ferreiros, 2.V.2001 *Cortez* 021/01 (SMDB 9243).

Distribution: South America (Singer & Digilio 1951; Wright & Albertó 2002), North America (Lincoff 1988; Murrill 1922), Europe (Breitenbach & Kränzlin 1995; Moser 1978; Noordeloos 1999; Watling & Gregory 1987), Africa (Pegler, 1977).

Remarks: *Stropharia coronilla* was recorded by Watling & Gregory (1987) with conspicuously germ-pored spores, but our collections agree with those recorded by Breitenbach & Kränzlin (1995) and Noordeloos (1999), whose collections were without a conspicuous germ-pore, from Switzerland and Netherlands respectively. *Stropharia coronilla* belongs to Section *Mundae* (Fr.) Konr. & Maubl. due the subviscid to dry pileus, the grooved annulus and the presence of true chrysocystidia (Noordeloos 1999). Some authors cite *S. coronilla* as a psilocin containing agaric (Sticht & Käferstein 2000), but Stijve & de Meijer (1993), who chemically analyzed southern Brazilian collections, and Ballero & Contu (1998) found neither psilocin nor psilocybin. In Brazil, *S. coronilla* has been previously recorded from the states of Pernambuco (Batista & Bezerra 1960), Paraná (Stijve & de Meijer 1993), and Rio Grande do Sul (Rick 1907, 1939, 1961; Singer 1953).

9. *Stropharia rugosoannulata* Farl. ex Murrill, Mycologia 14: 139, 1922.

Figure 8 A-E

Pileus 55-77(-150) mm diam., convex to applanate, robust; surface humid, smooth to slightly squamulose at the margin; color dark vinaceous brown, margin encurved, ondulate, with abundant appendiculate velar remnants; context fleshy and thick, white. **Lamellae** adnate, membranous; grayish to vinaceous brown; edges crenulated, whitish. **Stipe** 61-117 x 9-12 mm, central; cylindrical to sub-bulbous at base, with conspicuous basal mycelium; solid, striate above the annulus; white to cream. **Veil** well developed, forming a persistent, white, grooved, fleshy, thick, and striate annulus, and velar remnants at the pileus margin.

Basidiospores dark vinaceous brown in mass; 9.5-14.5 x 6.5-7 μm, subhexagonal in frontal view and ellipsoid in side view; smooth and thick-walled, with a wide germ-pore, brown. **Basidia** 21.5-38 x 8-11 μm, ventricose, with a medial constriction, tetrasporic. **Pleurocystidia** 24-53 x 6.5-13.5 μm, clavate to fusiform, as true chrysocystidia, with colored amorphous content. **Cheilocystidia** 22.5-45 x 6.5-17.5 μm, fusoid to mucronate, also as chrysocystidia, somewhat smaller than the pleurocystidia.

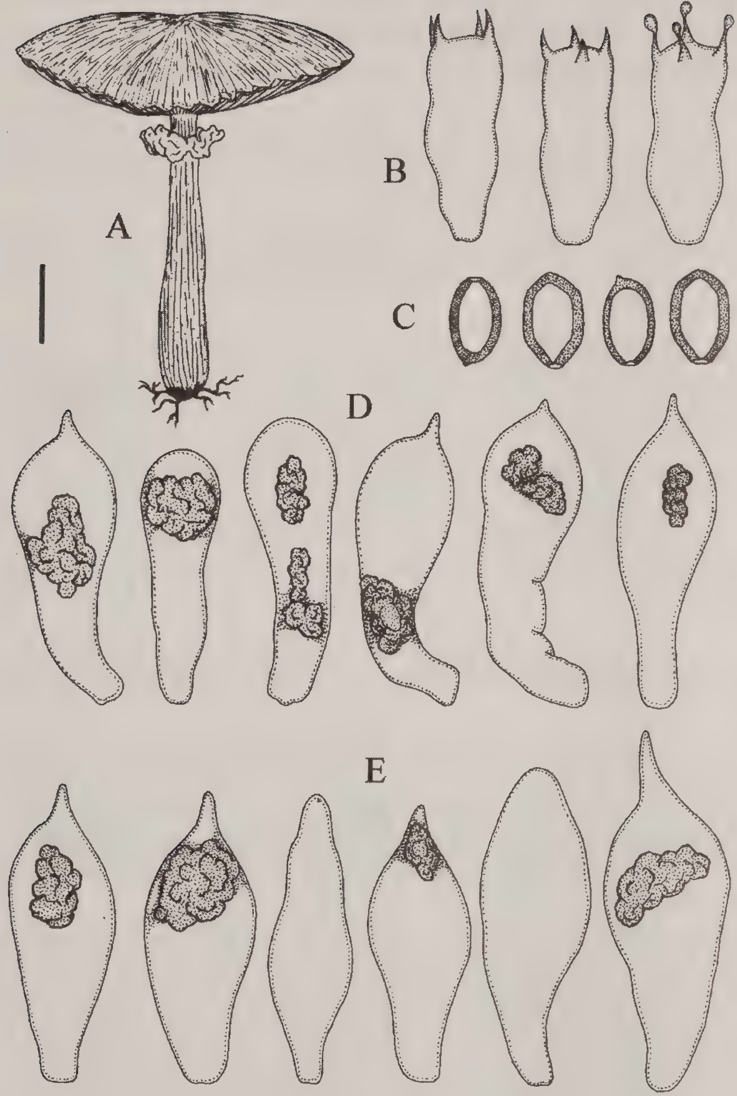

Figure 8. ***Stropharia rugosoannulata*:** A. Basidiome. B. Basidia. C. Basidiospores. D. Chrysocystidia. E. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10 μm.

Pileipellis is an ixocutis, composed of prostrate hyphae, incrusted with brownish pigment. **Hymenophoral trama** regular. **Clamp connections** present.

Ecology: Terrestrial, solitary or gregarious on soil and litter, in deciduous forests.

Material examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** Passo dos Ferreiros, 17.IV.2001 *Cortez* 018/01 (SMDB 9241); Morro do Elefante, 9.V.2001 *Cortez* 027/1 (SMDB 9247), 9.V.2001 *Cortez* 028/01 (SMDB 9248).

Distribution: North America (Murrill 1922), South America (Wright & Albertó 2002), Europe (Guinberteau 1978; Moser 1978; Wasser & Grodzinskaya 1996; Watling & Gregory 1987).

Remarks: *Stropharia rugosoannulata* is a good edible species, well studied and cultivated in many European countries (Singer 1986). Medicinal properties have been investigated by Grodzinskaya et al. (1999). There are only sporadic records of this species from South America. Wright & Albertó (2002) recorded it from Argentina, where seems to be used as food. In Brazil, *S. rugosoannulata* is not well documented and not consumed as food; previous records are from the states of São Paulo (Pegler 1997; Singer 1950) and Paraná (Stijve & de Meijer 1993). This is the first record of *S. rugosoannulata* from Rio Grande do Sul.

10. ***Stropharia semiglobata*** (Batsch: Fr.) Quél., Mem. Soc. d'Émul. Mont. Ser. II, 5: 112, 1872. FIGURE 9 A-E

Pileus 35 mm diam., hemispheric, somewhat umbonate; surface subviscid, smooth, pale yellow colored, margin striate, context fleshy, unchanging. **Lamellae** adnate, grayish to dark vinaceous brown, edges whitish. **Stipe** 104 x 4 mm, central, cylindrical, slightly expanded at base, elongated; color similar to pileus, subviscid. **Veil** forming a yellowish, glutinous annulus, at the upper part of the stipe.

Basidiospores dark vinaceous brown in mass; 17.5-21 x 9.5-12 μm, ellipsoid both in frontal and side view; brown, smooth and thick-walled, truncate by a broad germ-pore. **Basidia** 35-48 x 13.5-17 μm, clavate, hyaline, tetrasporic. **Pleurocystidia** 29.5-50.5 x 13-19 μm, mucronate to clavate, as true chrysocystidia, with amorphous refringent contents. **Cheilocystidia** 25.5-32 x 8-9.5 μm, hyaline, lageniform, abundant in the gill edge. **Pileipellis** an ixocutis of parallel and prostrate hyphae. **Hymenophoral trama** regular. **Clamp connections** present.

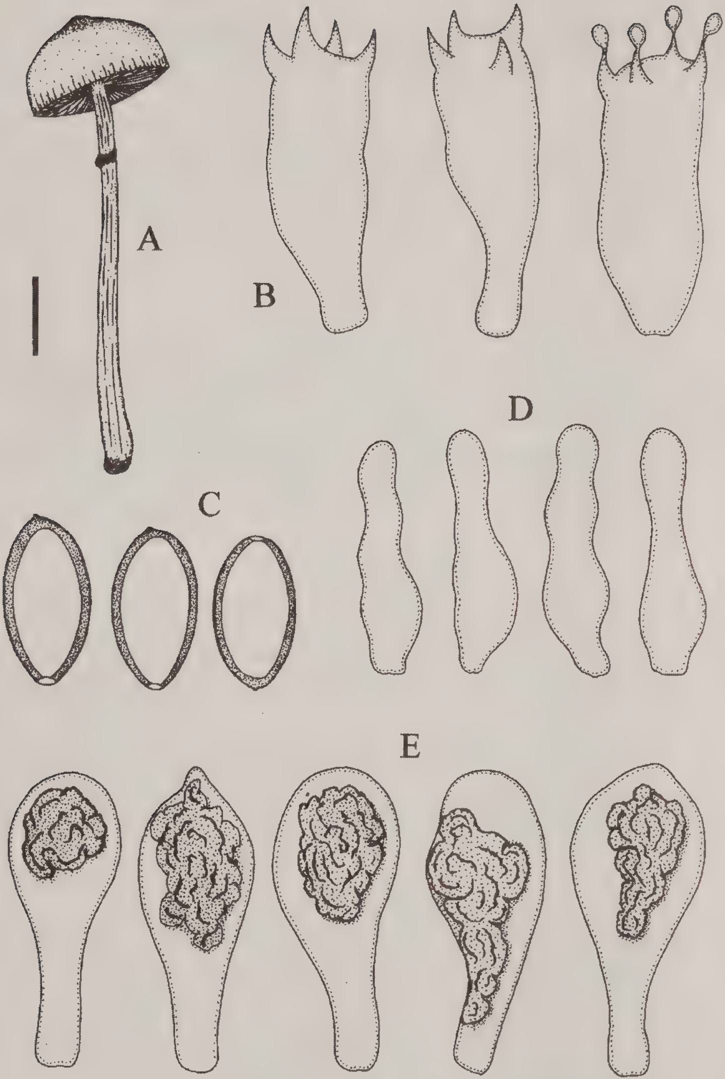

Figure 9. ***Stropharia semiglobata*****:** A. Basidiome. B. Basidia. C. Basidiospores. D. Chrysocystidia. E. Cheilocystidia. Scale bar: A = 20 mm; B-E = 10μm.

Ecology: Coprophilous, solitary on horse dung, in pastures.

Specimens examined: BRAZIL. Rio Grande do Sul: **Santa Maria,** Camobi, margin of the Vacacaí-Mirim river, near the Morro do Elefante, 23.IX.2000 *Cortez* 048/00 (SMDB, material lost).

Distribution: Europe (Breitenbach & Kränzlin 1995; Cacialli et al. 1995; Esteve-Raventós & Barrasa 1995; Kytövuory 1999; Moser 1978; Noordeloos 1999; Watling & Gregory 1987), North America (Lincoff 1988; Murrill 1922; Stamets 1996), South America (Dennis 1970; Pulido 1983; Singer & Moser 1964; Wright & Albertó 2002; Yokoyama 1984).

Remarks: *Stropharia semiglobata* is cited in the literature (e.g., Wright & Albertó, 2002) as a very common species on dung, but we have collected it only once during our study. It is very similar to *S. dorsipora* Esteve-Rav. & Barrasa, a European taxon that produces basidiospores with an eccentric germ pore, in contrast to the central germ pore found in *S. semiglobata* (Esteve-Raventós & Barrasa 1995; Noordeloos 1999). *Stropharia semiglobata* is known from the states of São Paulo (Bononi et al. 1984; Pegler 1997) and Rio Grande do Sul (Rick 1907, 1939, 1961).

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The senior author thanks all mycologists who have kindly sent him literature on stropharioid fungi, especially Gabrielle Cacialli (Italy), Gastón Guzmán (Mexico), Machiel Noordeloos (Netherlands), Manfred Enderle (Germany), Ronald Petersen (USA), and Solomon Wasser (Ukraine). Special thanks to Dr. Gastón Guzmán (Mexico) for critical review of the manuscript and confirming the identification of *Psilocybe pegleriana* and to Dr. Lorelei Norvell (Pacific Northwest Mycology Service, USA) for invaluable improvements of the paper. Thanks to Dr. Thaís Scotti do Canto-Dorow (Universidade Federal de Santa Maria, Brazil) and Dr. Jair Putzke (Universidade de Santa Cruz do Sul, Brazil) for their encouragement and support during this study. Thanks also to the curators of the herbaria PACA and ICN for the loan of specimens and to Felipe Wartchow (Universidade Federal de Pernambuco, Brazil) for companionship in some trip collections. FIPE/UFSM is acknowledged for the financial support given to the first author.

References

Ballero M, Contu M. 1998. Studi sui Basidiomiceti allucinogeni presenti in Sardegna: I. Funghi psilocibinici. Bol. Soc. Micol. Madrid 23: 119-126.

Batista AC, Bezerra JL. 1960. Basidiomycetes vulgares em o Nordeste Brasileiro. Publ. Inst. Micol. Univ. Recife 294: 1-30.

Bon M, Pacaud R. 2002. Contribution à l'étude du genre *Melanotus* Pat. en Vendée. Doc. Mycol. 32: 3-9.

Bononi VL, Mucci, ESF, Yokomizo NKS, Guzmán G. 1984. Agaricales (Basidiomycetes) do Parque Estadual de Campos do Jordão, SP, Brasil. Rickia 11: 85-89.

Breitenbach J, Kränzlin F. 1995. Champignons de Suisse. Tome 4/Pars 2: Entolomataceae, Pluteaceae, Amanitaceae, Agaricaceae, Coprinaceae, Bolbitiaceae et Strophariaceae. Lucerne: Mykologia Lucerne.

Cacialli G, Carotti V, Doveri F. 1995. Funghi fimicoli e rari o interessanti del littorale Toscano. Schede di Micologia Vol. 1. Trento: Associazione Micologica Bresadola.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Add. Ser. 3: 1-531.

Esteve-Raventós F, Barrasa JM. 1995. Coprophilous Agaricales from Spain II. The genus *Stropharia* and *Stropharia dorsipora* sp. nov. Rev. Iberoam. Micol. 12: 70-72.

Grodzinskaya AA, Wasser SP, Balaban PM. 1999. Testing of biologically active compounds in *Stropharia rugosoannulata* Farlow ex Murrill (Agaricales s.l., Basidiomycetes). Int. J. Med. Mushrooms 1: 229-233.

Guerrero RT, Homrich MH. 1983. Fungos macroscópicos comuns no Rio Grande do Sul: Guia para identificação. Porto Alegre: Ed. UFRGS.

Guerrero RT, Homrich MH. 1999. Fungos macroscópicos comuns no Rio Grande do Sul: Guia para identificação. 2 ed. Porto Alegre: Ed. UFRGS.

Guinberteau J. 1978. Découverte dans le sud-ouest du *Stropharia rugosoannulata* (Farlow ex Murrill) = *Stropharia ferri* (Bres). Doc. Mycol. 9: 35-39.

Guzmán G. 1978. The species of *Psilocybe* known from Central and South America. Mycotaxon 7: 225-255.

Guzmán G. 1983. The genus *Psilocybe*. Beih. Nova Hedwigia 74: 1-439,

Guzmán G. 2000. New species and new records of *Psilocybe* from Spain, the USA and Mexico, and a new case report of poisoning by *Psilocybe barrerae*. Doc. Mycol. 29: 41-52.

Guzmán G, Allen J, Gartz J. 2000. A worldwide distribution of the neurotropic fungi, an analysis and discussion. Ann. Mus. Civ. Rovereto 14: 189-280.

Guzmán G, Bononi VLR, Grandi RAP. 1984. New species, new varieties and a new record of *Psilocybe* from Brazil. Mycotaxon 19: 343-350.

Horak E. 1977. The genus *Melanotus* Pat. Persoonia 9: 305-327.

Kits Van Waveren E. 1979. *Melanotus proteus*, a species new to Europe. Trans. Br. Mycol. Soc. 73: 176-179.

Krieglsteiner GJ, Enderle M. 1986. Über neue, seltene, kritische makromyzeten in der Bundesrepublik Deutschland (Mitteleuropa) VII. Beitr. Kennt. Pilze Mitteleur. 2: 125-162.

Kühner R. 1984. Some mainlines of classification in the gill fungi. Mycologia 76: 1059-1074.

Kytövuori I. 1999. The *Stropharia semiglobata* group in NW Europe. Karstenia 39: 11-32.

Lincoff G. 1988.The Audubon Society field guide to North American mushrooms. New York: Alfred A. Knopf.

Longhi SJ, Araujo MM, Kelling MB, Hoppe JM, Müller I, Borsoi GA. 2000. Aspectos fitossociológicos de fragmento de Floresta Estacional Decidual, Santa Maria-RS. Ciência Florestal 10: 59-74.

Machado PF, Longhi SJ. 1990. Aspectos florísticos e fitossociológicos do “Morro do Elefante”, Santa Maria, RS. Rev. Centro de Ciências Rurais 20: 261-280.

Moser M. 1978. Die Röhrling und Blätterpilze (Polyporales, Boletales, Agaricales, Russulales). Stuttgart: Gustav Fischer Verlag.

Murrill WA. 1922. Dark-spored Agarics II. *Gomphidius* and *Stropharia*. Mycologia 14: 121-142.

Noordeloos ME. 1998. *Pholiota, Psilocybe* and *Panaeolus*. Fungi Non Delineati 4: 1-48.

Noordeloos ME. 1999. Strophariaceae. In: Bas C, Kuyper T, Noordeloos ME, Vellinga E. (eds.). Flora Agaricina Neerlandica. Vol. 4. Rotterdam: A.A. Balkema. Pp. 27-107.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bull. Add. Ser. 6: 1-615.

Pegler DN. 1983. The agaric flora of Lesser Antilles. Kew Bull. Add. Ser. 9: 1-668.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bull. Add. Ser. 12: 1-519.

Pegler DN. 1988. A revision of the Agaricales of Cuba. Kew Bull. 42-43: 1-139.

Pegler DN. 1989. Agaricales of Brazil described by J.P.F.C. Montagne. Kew Bull. 45: 161-177.

Pegler DN. 1997. The agarics of São Paulo, Brazil. London: HMSO, Royal Bot. Gardens, Kew.

Pereira PRB, Garcia-Netto LR, Borin CJA, Barros-Sartori MG. 1989. Contribuição à geografia física do município de Santa Maria: unidades de paisagem. Geografia: Ensino & Pesquisa 3: 37-68.

Pratt JE, Quill K. 1996. A trial of disodium octaborate tetrahydrate for the control of *Heterobasidium annosum*. Eur. J. For. Pathol. 26: 297-305.

Pulido MM. 1983. Estudios en Agaricales Colombianos – Los hongos de Colombia IX. Bogotá: Instituto de Ciencias Naturales/Museo de Historia Natural.

Quadros FL, Bica GS, Damé PRV, Dorow R, Kersting C, Pötter L. 2003. Levantamento das pastagens naturais da região de Santa Maria-RS. Ciência Rural 33: in press.

Redfern DB. 1991. *Melanotus proteus*: a newly recorded colonist of Sitka spruce stumps in Britain and a potential competitor of *Heterobasidion annosum*. Plant Pathol. 40: 483-486.

Reid DA, Eicker A. 1999. South African fungi 10: new species, new records and some new observations. Mycotaxon 73: 169-197.

Rick J. 1907. Contributio ad monographiam Agaricacearum et Polyporacearum Brasiliensium. Broteria, Sér. Bot. 6: 65-92.

Rick J. 1930. Contributio ad monographiam Agaricacearum et Polyporacearum Brasiliensium. IV. Broteria, Sér. Bot. 24: 27-114.

Rick J. 1939. Agarici Riograndensis III. Lilloa 4: 75-104.

Rick J. 1961. Basidiomycetes Eubasidii in Rio Grande do Sul – Brasilia 5. Agaricaceae. Iheringia, Sér. Bot. 8: 296-450.

Sime DA, Petersen R. 1999. Intercontinental interrelationships among disjunct populations of *Melanotus* (Strophariaceae, Agaricales). Mycotaxon 71: 481-492.

Singer R. 1950. Type studies on Basidiomycetes. Lilloa 23: 147-246.

Singer R. 1953. Type studies on Basidiomycetes VI. Lilloa 26: 57-159.

Singer R. 1986. The Agaricales in modern taxonomy. 4ed. Königstein: Koeltz Scientific Books.

Singer R, Digilio APL. 1951. Pródromo de la Flora Agaricina Argentina. Lilloa 25: 6-461.

Singer R, Moser M. 1964. Forest mycology and forest communities in South America. Mycopath. Mycol. Appl. 26: 129-191.

Smith AH. 1951. The North-American species of *Naematoloma*. Mycologia 43: 467-521.

Smith AH. 1979. Generic relationships within the Strophariaceae of the Agaricales. Taxon 28: 19-21.

Sotão HMP, Bononi VLR, Figueiredo TS. 1991. Basidiomycetes de manguezais da Ilha de Maracá, Amapá, Brasil. Bol. Mus. Paraense Emílio Goeldi, Ser. Bot. 7: 109-114.

Stamets P. 1996. Psilocybin mushrooms of the world. Berkeley: Ten Speed Press.

Sticht G, Käferstein H. 2000. Detection of psilocin in body fluids. Forensic Sci. Int. 113: 403-407.

Stijve T, de Meijer AAR. 1993. Macromycetes from the state of Paraná. 4. The psychoactive species. Arq. Biol. Tecnol. 36: 313-329.

Thomas KA, Manimohan P, Guzmán G, Tapia F, Ramírez-Guillén F. 2002. The genus *Psilocybe* in Kerala State, India. Mycotaxon 83: 195-207.

Vesterholt J. 1993. Filtet strahat (*Melanotus proteus*) fundet i Danmark. Svampe 27: 15-16.

Vinha PC. 1988. Fungos macroscópicos do Estado do Espírito Santo depositados no Herbário Central da Universidade Federal do Espírito Santo, Brasil. Hoehnea 15: 57-64.

Watling R, Gregory N. 1987. British Fungus Flora 5: Strophariaceae and Coprinaceae p.p. Edinburgh: HMSO/Royal Botanic Garden Edinburgh.

Wasser SP, Grodzinskaya AA. Contributions to the taxonomy of the family Strophariaceae Sing. et A.H. Sm. (Higher Basidiomycetes). In: Wasser, SP. (ed.). Botany and Mycology for the Next Millenium. Kiev: National Academy of Sciences of Ukraine, 1996. Pp. 372-405.

Wright JE, Albertó E. 2002. Hongos: Guía de la Región Pampeana. I. Hongos con laminillas. Buenos Aires: L.O.L.A.

Yokoyama K. 1984. Coprophilous macrofungi from southern Chile. In: Inoue H. (ed.). Studies on cryptogams in southern Chile. Tokyo: Kenseisha. Pp. 153-159.

Yokoyama K. 1987. The coprophilous species of *Psilocybe* (Agaricales, Basidiomycetes) from Peru. In: Inoue H. (ed.) Studies on cryptogams in southern Peru. Tokyo: Tokai University Press. Pp 145-149.

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Megasporoporia (Aphyllophorales, Basidiomycota*)* in China

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Abstract—The knowledge on the species of *Megasporoporia (Aphyllophorales,* Basidiomycota*)* from China is summarised in this paper, and four species in the genus are recorded from the country. An identification key, including statistical variations of the spore dimensions of each species, is supplied. Two new species, *Megasporoporia quercina* and *M. subcavernulosa*, are described and illustrated. *M. quercina* is characterized by its perennial habit, extensive basidiocarps, the abundance of hyphal pegs at dissepiment edges and tube walls, smaller basidiospores, and by its growth on fallen trunks of *Quercus*. *M. subcavernulosa* resembles *M. cavernulosa*, but differs by having smaller basidiospores, and by the presence of both hyphal pegs and dendrohyphidia. Moreover, *M. cavernulosa* is widely distributed in tropical America and Africa, while *M. subcavernulosa* is found in temperate and warm temperate areas of East Asia. Specimens of *M. setulosa* collected from China were studied, and their basidiospores are smaller than in specimens from tropical America.

Key words—polypores, taxonomy, wood-rotting fungi

Introduction

Megasporoporia Ryvarden & J.E. Wright was established with *Poria setulosa* Henn. as the type species (Ryvarden et al. 1982). The genus is characterized by large pores, long and cylindric basidiospores, clamp connections on generative hyphae, and by dextrinoid skeletal hyphae with arboriform branches (the so-called skeleto-binding hyphae). Because the skeletal hyphae are dentritically branched in *Megasporoporia,* a hyphal structure similar to that in the genera *Dichomitus* D.A. Reid and *Polyporus* P. Micheli ex Adams.:Fr. *sensu str., Megasporoporia* was recently merged in *Dichomitus* (Masuka & Ryvarden 1999). However, *Megasporoporia* usually has shallow pores, plenty of hyphal pegs, dextrinoid skeletal hyphae, dendrohyphidia, and polyhedric crystals in most species. Taxa sharing these characters constitute in our opinion a natural group, and in the present study *Megasporoporia* is treated as an independent genus.

Before this study, two species of *Megasporoporia* were recorded from China (Hattori 1995, Dai & Li 2002). During the survey of wood-rotting fungi in China, more specimens belonging to this genus were studied, and four species, including two new ones, were found. In this paper we describe the new taxa, and give notes on some other species.

Materials and methods

This study is mainly based on the following materials: the collections of the authors from the Yunnan and Hainan provinces of China; specimens from other parts of China collected by Tsutomu Hattori (Japan, TFM-F), Guo-Yang Zheng (China, HMIGD) and Emilio Licent (the Czech Republic, PRM). The herbaria of the studied materials are mentioned in the text. For comparison, some American collections were studied to support our results.

The microscopic routine used in the study is as presented by Dai and Niemelä (1997). In the text the following abbreviations are used: L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width of each specimen), n=(x/y) means the number (x) of spores (or other structures) measured from given number (y) of specimens. In presenting the variation in the size of spores, 5% of the measurements were excluded from each end of the range, and are given in parentheses; IKI stands for Melzer's reagent and KOH for 5% potassium hydroxide, and CB is the abbreviation of Cotton Blue. CB+ means cyanophilous and CB– acyanophilous; IKI+ means amyloid and IKI– means both inamyloid and indextrinoid. The authors of the scientific names were abbreviated mostly according to Brummitt and Powell (1992).

Results

Descriptions

Megasporoporia quercina Y.C. Dai, *sp. nov.* (Figs. 1-2)

> *Carpophorum perenne, resupinatum. Facies pororum cremea vel pallide ravido-cremea; pori 1–2 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales subiculi 2.2 –3.5 µm in diam. Sporae hyalinae, cylindricae, 5.6–8 × 2.3–3 µm.*

Type: China. Yunnan Province, Lijiang County, Heishuihe, mixed broad-leaved forest, on fallen decorticated trunk of *Quercus*, 15.VI.1999 *Dai 3054* (holotype in IFP; isotype in H).

Etymology. — *quercina* (Lat.): referring to the host tree genus *Quercus*.

Fruitbody. — Basidiocarps perennial, resupinate, difficult to separate from substrate, leathery when fresh, becoming hard upon drying, up to 150 cm long, 15 cm wide, and 4 mm thick. Pore surface cream to pale greyish cream when fresh, becoming greyish cream to pale straw coloured upon drying; pores mostly round, sometimes slightly irpicoid, freely arranged, 1–2 per mm; dissepiments thin, lacerate, bearing abundant hyphal pegs (easily seen by lens). Subiculum pale straw coloured, hard corky, up to 0.5 mm thick. Tubes concolorous with poroid surface, tubes hard, up to 3 mm long, tube walls bearing crowded hyphal pegs, tubes stratified, tube layers usually distinct.

Hyphal structure. — Hyphal system dimitic, generative hyphae with clamp connections, hyaline, thin-walled; skeletal hyphae thick-walled with a narrow lumen to subsolid, unchanged in KOH, dextrinoid, CB+.

Subiculum. — Hyphae of the context tightly interwoven, agglutinated; generative hyphae infrequent, occasionally branched, 2–4 µm in diam; skeletal hyphae dominant, thick-walled, flexuous, dentritically branched, 2.2–3.5 µm in diam.

Tubes. — Tramal hyphae tightly interwoven, strongly agglutinated; generative hyphae infrequent, thin-walled, occasionally branched, 2–3.5 µm in diam; skeletal hyphae dominant, mostly subsolid, dentritically branched, 2–3.3 µm in diam. Cystidia and cystidioles absent, hyphal pegs frequent, some of them submerged in trama, mostly penetrating into hymenium. Hyphae of hyphal pegs hyaline, thick-walled, straight, strongly agglutinated, parallel along the peg, strongly dextrinoid, CB+, 2–3 µm in diam. Basidia narrowly clavate, with a basal clamp and four sterigmata, 20–26 × 4–6 µm; basidioles in shape similar to basidia, but slightly smaller. Polyhedric crystals frequent among subhymenium and hymenium. Dendrohyphidia frequent in hymenium and the edges of dissepiments.

Spores. — Basidiospores cylindrical, hyaline, thin-walled, smooth, glued in tetrads, CB–, IKI–, (5.1–)5.6–8(–8.2) × (2.1–)2.3–3(–3.5) µm, L = 6.56 µm, W = 2.71 µm, Q = 2.42 (n=60/1).

Five species of *Megasporoporia* were detected: *M. cavernulosa* (Berk.) Ryvarden, *M. setulosa* (Henn.) Rajchenb., *M. hexagonoides* (Speg.) J.E. Wright & Rajchenb., *M. mexicana* Ryvarden and *M. major* (G.Y. Zheng & Z.S. Bi) Y.C. Dai & T.H. Li. Among them the first two species have shorter spores (10–16 × 5–7 µm in *M. cavernulosa* (Ryvarden et al. 1982) and 8–11 × 3.5–4.2 µm in *M. setulosa*), and the three last-mentioned species have long spores (16.6–21.8 × 5.2–6.8 µm in *M. hexagonoides* and 20–26 x 6–9 µm in *M. mexicana,* Ryvarden et al. 1982; 15.2–20 × 5.5–7.1 µm in *M. major*).

Megasporoporia quercina differs mainly from the other species of *Megasporoporia* by its distinctly smaller basidiospores, and it is perennial, in contrast to the annual habit in the other species of the genus. In addition, *M. quercina* produces extensive basidiocarps (up to 150 cm long, 15 cm wide) on large decorticated trunks of *Quercus*, but the other species of the genus usually form just small patches on fallen branches of angiosperm trees. Another distinct character of the new species is the abundance of its hyphal pegs in both dissepiments and tube walls; the hyphae of the pegs are strongly dextrinoid.

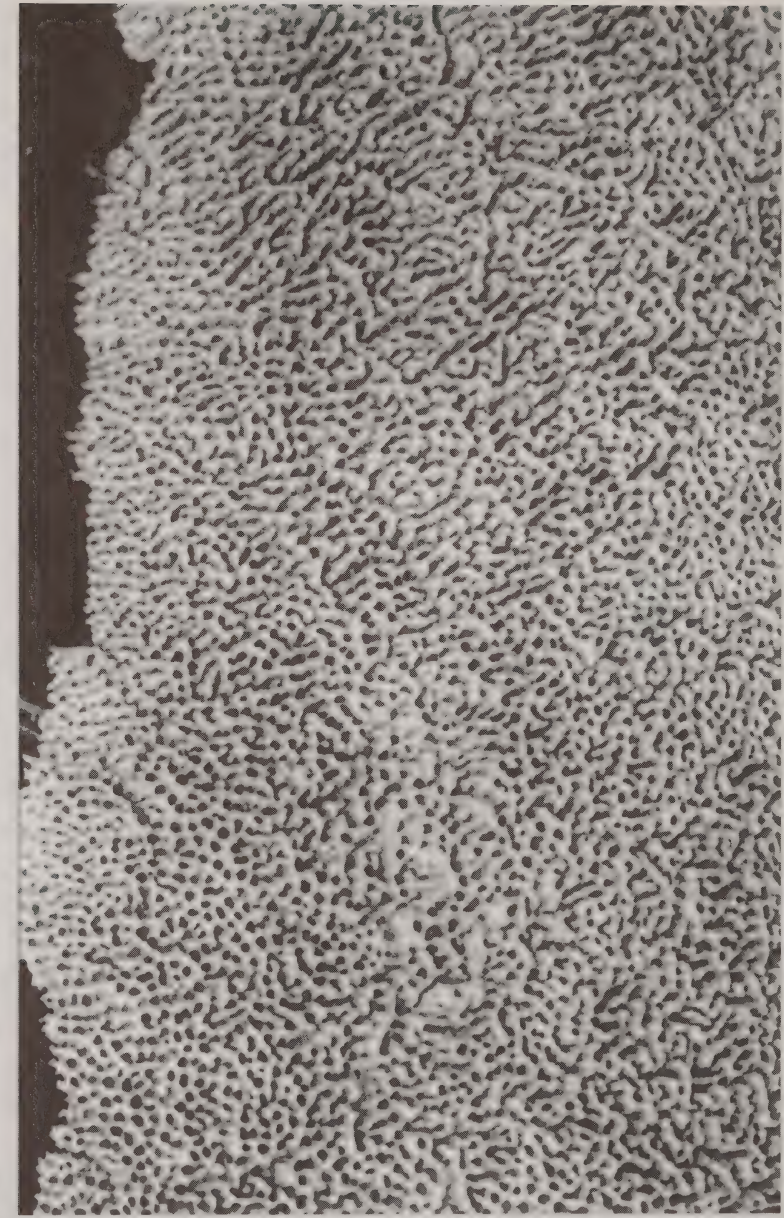
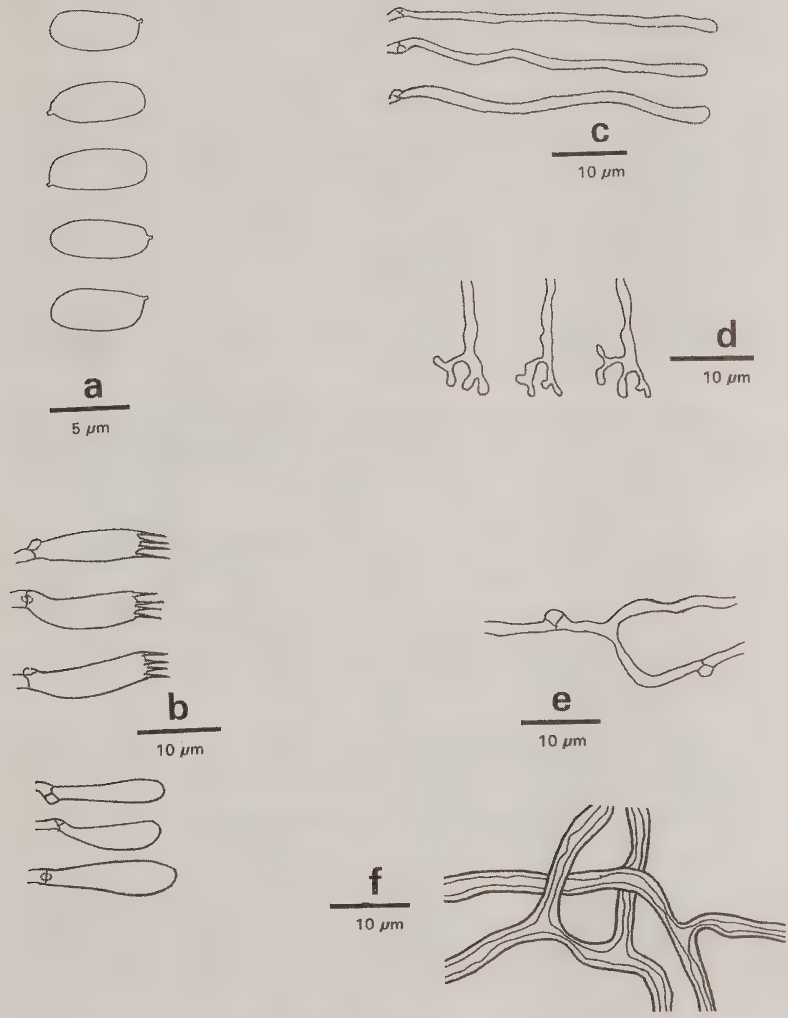


Fig. 1. *Megasporoporia quercina*. A fresh basidiocarp, specimen *Dai 3054*. Photograph Y.C. Dai *in situ*, × 1.1 .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a
5 μm
d
10 μm
b
10 μm
e
10 μm
f
10 μm

Fig. 2. Anatomical details of *Megasporoporia quercina* (drawn from the holotype). — a: Basidiospores. — b: Basidia and basidioles. — c: Cystidioles. — d: Dendrohyphidia from dissepiment edge. — e: Generative hyphae from subiculum. — f: Skeletal hyphae from subiculum.

Dichomitus eucalypti Ryvarden was described on *Eucalyptus* from Australia (Ryvarden 1985). Its basidiospores are rather similar to those in *Megasporoporia quercina,* but the former species has smaller pores (2–3 per mm), and it lacks dendrohyphidia and hyphal pegs. Its basidiospores are wider, 7–8.5 × 3–4 µm, and its skeletal hyphae are negative in Melzer's reagent.

Grammothele Berk. & M.A. Curtis is closely related to *Megasporoporia,* and species of the latter genus were for some time included in the former one (Ryvarden & Johansen 1980). Species having large pores, big basidiospores, and a distinctly poroid hymenophore were later separated from *Grammothele,* and they were treated in *Megasporoporia* by Ryvarden et al. (1982). Basidiospores of *M. quercina* are not as large as in most species of *Megasporoporia,* and they are closer to the spores of *Grammothele,* and so *M. quercina* seems to be an intermediate species between *Grammothele* and *Megasporoporia.* However, the new species has distinct pores, cylindrical basidiospores, and its skeletal hyphae are distinctly branched and dextrinoid. These characters indicate it to be closely related to *M. setulosa* and the other species of the genus, and therefore we treat it accordingly.

Additional specimen examined (paratype). — China. Yunnan Prov., Lijiang County, Heishuihe, mixed broad-leaved forest, on fallen decorticated trunk of *Quercus*, 15.VI.1999 *Dai 3052* (IFP).

Megasporoporia subcavernulosa Y.C. Dai & Sheng H. Wu, *sp. nov.* (Fig. 3)

> *Carpophorum annuum, resupinatum. Facies pororum cremea vel pallide ravida; pori 2–4 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales subiculi 2–3.8 µm in diam. Sporae hyalinae, cylindricae, 9–12.1 x 4.2–5.2 µm.*

Type: China. Yunnan Prov., Kunming, Xishan Park, on fallen twig of *Cyclobalanopsis*, 25.VIII.1995 *Wu 9508–328* (holotype in TNM).

Etymology. — *subcavernulosa* (Lat.): somewhat resembling *M. cavernulosa.*

Fruitbody. — Basidiocarps annual, resupinate, difficult to separate from substrate, leathery when fresh, becoming hard corky upon drying, up to 7 cm long, 1 cm wide, and 1.5 mm thick. Pore surface cream when fresh, becoming pale greyish upon drying; pores round, freely arranged, 2–4 per mm; dissepiments thin, entire. Subiculum cream, corky, up to 0.5 mm thick. Tube layer concolorous with pore surface, tubes hard corky, up to 1 mm long.

Hyphal structure. — Hyphal system dimitic, generative hyphae with clamp connections, hyaline, thin-walled; skeletal hyphae thick-walled with a narrow lumen or subsolid, unchanged in KOH, dextrinoid, CB+.

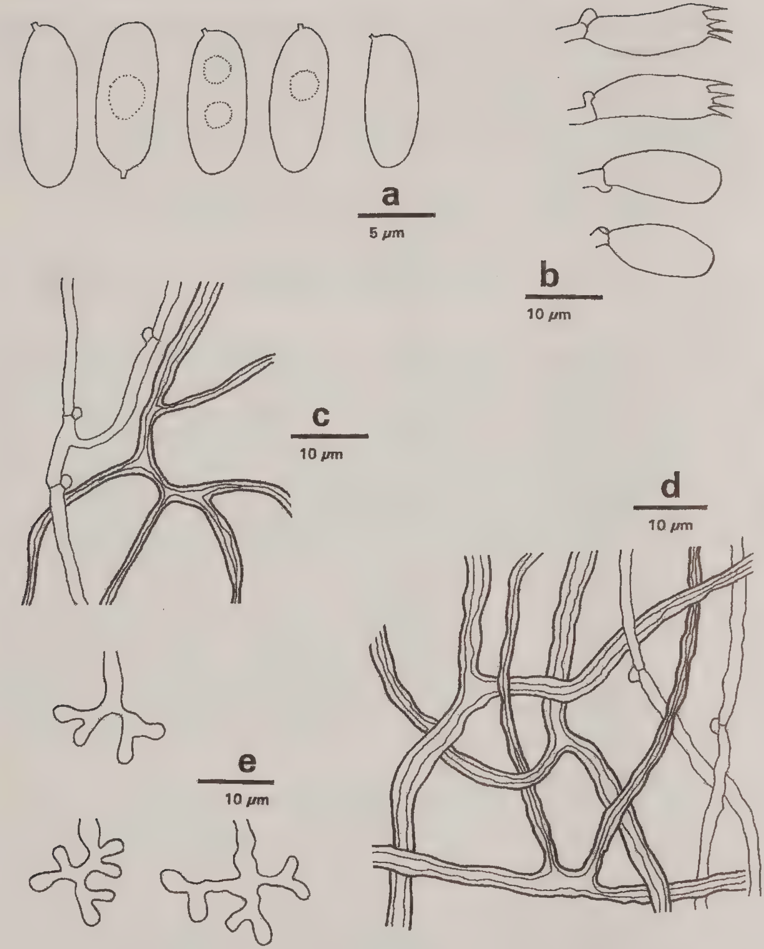
a
5 µm
b
10 µm
c
10 µm
d
10 µm
e
10 µm

Fig. 3. Anatomical details of *Megasporoporia subcavernulosa* (drawn from the holotype). — a: Basidiospores. —b: Basidia and basidioles. —c: Hyphae from trama. —d: Hyphae from subiculum. —e: Dendrohyphidia from dissepiment edge.

Subiculum. — Hyphae in subiculum tightly interwoven, agglutinated; generative hyphae infrequent, hyaline, thin-walled, 2–3.5 µm in diam; skeletal hyphae dominant, thick-walled, occasionally branched in the apical parts, flexuous, some encrusted, 2–3.8 µm in diam.

Tubes. — Tramal hyphae tightly interwoven, strongly agglutinated; generative hyphae infrequent, thin-walled, 1.8–3.3 µm in diam; skeletal hyphae dominant, mostly subsolid, branched in an arboriform fashion, 2–3.5 µm in diam. Cystidia and cystidioles absent, hyphal pegs frequent; hyphae of pegs hyaline, thin-walled, frequently septate with clamp connections, weakly dextrinoid, slightly CB+. Basidia clavate, with a basal clamp and four sterigmata, 18–24 × 8–11 µm; basidioles in shape similar to basidia, but distinctly smaller. Polyhedric crystals frequent among subhymenium and hymenial elements. Dendrohyphidia frequent in hymenium and the edges of dissepiments.

Spores. — Basidiospores cylindrical, hyaline, thin-walled, smooth, CB–, IKI–, (8.5–)9–12.1(–13.2) × (4–)4.2–5.2(–6) µm, L = 10.27 µm, W = 4.77 µm, Q = 2.09–2.42 (n=120/4).

Megasporoporia subcavernulosa was first recorded as *Poria ambigua* Bres. (*Oxyporus latemarginatus* (Dur. & Mont.) Donk) from the Shanxi Province in northern China (Pilát 1940). However, after examining its voucher specimen, it turned out to be a distinct species of *Megasporoporia. M. cavernulosa* (Berk.) Ryvarden was reported from Zhejiang Province, eastern China (Hattori 1995). Its cited material was studied, and it has both hyphal pegs and dendrohyphidia. In addition, basidiospores of the specimen are distinctly smaller than in *M. cavernulosa* (9.2 –11 × 4.3–5.1 µm vs. 10–16 × 5–7 µm, Ryvarden et al. 1982). Furthermore, specimens from Yunnan (southwestern China) and Primorye (the Russian Far East) were studied, they are identical to the material collected from Zhejiang and Shanxi. The new species, *M. subcavernulosa,* is described here on the basis of these materials. *M. subcavernulosa* is closely related to *M. cavernulosa*, but differs by having smaller basidiospores, and by having both hyphal pegs and dendrohyphidia. Furthermore, *M. cavernulosa* is widely distributed in tropical America and Africa, while *M. subcavernulosa* is found in the temperate and warm temperate areas of East Asia only.

Additional specimens examined (paratypes). — China. Shanxi Prov., Yaochan, on angiosperm, 2.IX.1935 *Licent 4925* (PRM 806786). Zhejiang Prov., Baishanzu Mts., VII.1994 *Hattori* (TFM-F). Russia. Primorye Terr., Hasan, 23.VII.1985 *Parmasto* (TAA 106222).

Key to species of *Megasporoporia* from China

(statistical variations of spore dimensions of each species are included)

1. Basidiospores < 8.5 µm in length . . . . *M. quercina*
(5.1–)5.6–8(–8.2) × (2.1–)2.3–3(–3.5) µm,
L = 6.56 µm, W = 2.71 µm, Q = 2.42 (n=60/1)
1. Basidiospores > 8.5 µm in length 2

2. Basidiospores > 14 µm in length . . . . *M. major*
(14.7–)15.2–20(–22) × (5–)5.5–7.1(–7.5) µm,
L = 17.82 µm, W = 6.57 µm, Q = 2.72 (n=60/1)
2. Basidiospores < 14 µm in length 3

3. Pores 2–4 per mm; dendrohyphidia present along hymenium and in dissepiment edges . . . . *M. subcavernulosa*
(8.5–)9–12.1(–13.2) × (4–)4.2–5.2(–6) µm,
L = 10.27 µm, W = 4.77 µm, Q = 2.09–2.42 (n=120/4)
3. Pores 1–2 per mm; dendrohyphidia absent from hymenium and in dissepiment edges . . . . *M. setulosa*
(7.2–)8–11(–11.2) × (3.1–)3.5–4.2(–4.5) µm,
L = 9.24 µm, W = 3.77 µm, Q = 2.45 (n=30/1)

Notes on other species

Two specimens of *Megasporoporia setulosa* from Taiwan and Hainan were studied; basidiospores of the Chinese materials are smaller than those from tropical America (8–11 x 3.5–4.2 µm vs. 10–14 x 4–6 µm, Gilbertson and Ryvarden, 1986–1987), but all the other characters fit the species well. *M. setulosa* is similar to *M. cavernulosa,* but differs from the latter one by having larger pores, and by lacking dendrohyphidia.

Megasporoporia *major* was originally described from the Guangdong Province, subtropical China, as *Pachykytospora major* G.Y. Zheng & Z.S. Bi. Dai and Li (2002) merged it in *Megasporoporia* because it has smooth basidiospores, and its hyphal structure is very similar to that in the other *Megasporoporia* species.

Other *specimens examined. — Megasporoporia major*. China. Guangdong Prov., Huidong County, Gutian, on branch of angiosperm, 26.XI.1986 *Zheng* (HMIGD). *Megasporoporia setulosa.* China. Hainan Prov., Ledong County, Jianfengling Nat. Res., on fallen branch of angiosperm, 21.IX.2002 *Dai 4373* (IFP). Taiwan, Gaoxiong, Liukuei, Shanping, on branch of angiosperm, 22.12.1993 *Wu 9312-54* (TNM). Jamaica, Trewlany Crowlands, on dead wood, 10.VI.1999 *Ryvarden 41574* (O).

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Literature cited

Brummitt PK, Powell CE. 1992. Authors of plant names. Royal Botanic Gardens, Kew, UK.

Dai YC, Li TH. 2002. *Megasporoporia major* (Basidiomycota), a new combination. Mycosystema 21: 519–521.

Dai YC, Niemelä T. 1997. Changbai wood-rotting fungi 6. Study on *Antrodiella*, two new species and notices on some other species. Mycotaxon 64: 67–81.

Hattori T. 1995. List of polypores collected in East China. Bull. Nat. Sci. Mus., Tokyo, Ser. B, 21: 95–105.

Gilbertson RL, Ryvarden L. 1986–1987. North American polypores 1–2. Fungiflora, Oslo, Norway.

Masuka AJ, Ryvarden L. 1999. *Dichomitus* in Africa. Mycol. Res. 103: 1126–1130.

Pilát A. 1940. Basidiomycetes chinenses. Ann. Mycol. 38: 61–82.

Ryvarden L. 1985. *Dichomitus eucalypti sp. nov. (Polyporaceae,* Basidiomycotina*)*. Trans. British Mycol. Soc. 85: 539–540.

Ryvarden L, Johansen I. 1980. A preliminary polypore flora of East Africa. Fungiflora, Oslo, Norway.

Ryvarden L, Wright JE, Rajchenberg M. 1982. *Megasporoporia,* a new genus of resupinate polypores. Mycotaxon 16: 172–182.

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Notes on the genus *Antrodiella* (Basidiomycota, *Aphyllophorales*) in China

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Abstract—Antrodiella micra (Basidiomycota, Aphyllophorales) from northeastern China is described and illustrated. It has resupinate or effused-reflexed basidiocarps, snow-white hymenophore when fresh, small pores (7–9 per mm), small and broadly ellipsoid basidiospores, and it grows on wood of angiosperms decayed by some species of the Hymenochaetaceae. The new species resembles A. pallasii, which has pale yellowish pore surface when fresh, and somewhat larger pores (6–7 per mm). In addition, A. pallasii usually grows on spruce trees decayed by Trichaptum abietinum. An identification key to the species of Antrodiella from China is provided along with a synoptic description of each species.

Key words—polypores, taxonomy, wood-rotting fungi

Introduction

The genus *Antrodiella* Ryvarden & I. Johans. was established by Ryvarden and Johansen (1980) to embrace the *Polyporus semisupinus* Berk. & M.A. Curtis complex. The species of *Antrodiella* usually have small pores, light colours, resupinate to pileate basidiocarps with a dimitic or trimitic hyphal system, small basidiospores, but no cystidia, and they cause a white rot of dead wood. The genus was originally defined mostly by European and North American species. *Antrodiella* has been intensively studied during the past 20 years, and more species have been subsequently described in or transferred into the genus (Vampola 1991, Hattori & Ryvarden 1993, Ryvarden & Gilbertson 1993, Vampola & Pouzar 1996, Dai & Niemelä 1997, Johannesson, Renvall & Stenlid 2000). The added species have greatly expanded the original definition of the genus by including species with irpicoid to dentate hymenophore, e.g. *A. foliaceodentata* (Nikol.) Gilb. & Ryvarden and *A. zonata* (Berk.) Ryvarden; species with large pores, e.g. *A. americana* Ryvarden & Gilb. and *A. aurantilaeta* (Corner) T. Hattori & Ryvarden; species with yellow colouration, e.g. *A. albocinnamomea* Y.C. Dai & Niemelä and *A. citrinella* Niemelä & Ryvarden; species having hymenial cystidia, e.g. *A. albocinnamomea* and *A.*

parasitica Vampola; and species with a stipe, e.g. *A. liebmannii* (Fr.) Ryvarden. However, an important and consistent character in all species of the genus is the cyanophilous colour reaction of the skeletal hyphae.

Species of *Antrodiella* from Northeast China were reported by Dai and Niemelä (1997). Subsequently more material from other parts of China was studied, and 12 species, including one previously undescribed, are now recognized. In this paper I give an illustrated description of the new species, and compile a key for the 12 species of my research area. A synoptic description of each species is given in the key, along with data on spore size variation measured mostly from the Chinese material. Other species of *Antrodiella* from East Asia were previously summarized by Núñez and Ryvarden (2001).

Materials and methods

Most of the material in the present study was collected by the author from Northeast, Southwest and Central China during field trips in 1993–2002; some specimens were collected by Marja Härkönen (Helsinki, Finland) from Hunan Province, subtropical China. The specimens studied are preserved in the Herbarium of the Institute of Applied Ecology, Academia Sinica (IFP), and duplicates are deposited in the Botanical Museum of the University of Helsinki (H). Some specimens were obtained as loans from HMAS (China), TFM (Japan), BPI (USA) and PRM (Czech Republic). For comparison some European and North American specimens were studied. The microscopic routine used was that described by Dai and Niemelä (1997). In the text the following abbreviations are used: Frb. = Fruitbody, L = mean spore length (arithmetical mean of all spores), W = mean spore width (arithmetical mean of all spores), Q = variation in the L/W ratios between the specimens studied (quotient of the mean spore length and the mean spore width of each specimen), n=x/y means the number (x) of spores (or other structures) measured from given number (y) of specimens. In presenting variation in the size measurements of spores, hyphae, pores and spines, 5% of the measurements were excluded from each end of the range and are given in parentheses. IKI stands for Melzer's reagent, KOH for 5% potassium hydroxide, and CB for Cotton Blue. CB+ means cyanophilous and CB– acyanophilous; IKI– means both inamyloid and indextrinoid. The authors of scientific names have been abbreviated mostly according to Brummitt and Powell (1992).

Results

Key to species of *Antrodiella* from China

(synoptic description of each species is provided)

1. Hymenophore irpicoid to dentate . . . . *A. zonata*

Frb. annual, mostly pileate, sometimes effused-reflexed, upper surface zonate; hymenophore pale yellowish, becoming yellowish brown with age, irpicoid or toothed, spines 2–4 per mm; tramal hyphae parallel along tubes, basidiospores oblong-ellipsoid, IKI–, CB–,

(3.8–)4.4–6(–6.5) × (2.7–)3–4(–4.3) µm,
L = 5.14 µm, W = 3.39 µm, Q = 1.44–1.59 (n=90/3).

1. Hymenophore poroid 2

2. Pores 1–3 per mm 3
2. Pores > 3 per mm 4

3. Basidiocarps resupinate, pores cream coloured . . . . *A. americana*
Frb. annual, resupinate; pore surface cream coloured, pores 1–2 per mm; tramal hyphae interwoven, gloeocystidia present, basidiospores oblong-ellipsoid, IKI–, CB–,
(2.9–)3–4(–4.5) × (1.2–)1.4–2(–2.2) µm,
L = 3.50 µm, W = 1.82 µm, Q = 1.77–2.18 (n=120/4).
3. Basidiocarps effused-reflexed, pores orange coloured . . . . *A. aurantilaeta*
Frb. annual, effused-reflexed; pore surface orange yellow, pores 1–2 per mm; tramal hyphae interwoven, basidiospores oblong-ellipsoid, IKI–, CB–,
(2.7–)2.8–4.3(–5.2) × (1.4–)1.7–2.2(–2.3) µm,
L = 3.38 µm, W = 1.95 µm, Q = 1.57–1.91 (n=66/2).

4. Pileus brown to deep bay, context brown and darker than tubes . . . .*A. liebmannii*
Frb. annual to perennial, sessile or stipitate, upper surface brown to purplish black, zonate; pore surface tan to dull straw coloured, pores 14–16 per mm; tramal hyphae loosely parallel, basidiospores ellipsoid, IKI–, CB–,
(2.7–)2.8–3.8(–3.9) × (1.4–)1.5–2(–2.1) µm,
L = 3.10 µm, W = 1.73 µm, Q = 1.79 (n=30/1).
4. Pileus cream or straw coloured, tan or yellowish, context concolorous with the tubes 5

5. Pore surface yellowish 6
5. Pore surface cream coloured, never yellowish 9

6. On gymnosperms; basidiospores broadly ellipsoid to subglobose 7
6. On angiosperms; basidiospores oblong-ellipsoid to subcylindrical 8

7. On white rot wood decayed by *Trichaptum*; basidiocarps mostly > 5 cm in longest dimension, pores 6–7 per mm; basidiospores usually bearing a guttule, < 2.1 µm in width . . . . *A. pallasii* Renvall, Johannesson & Stenlid
Frb. annual, resupinate or effused-reflexed; pore surface cream coloured to pale yellowish, pores 6–7 per mm; tramal hyphae interwoven, basidiospores broadly ellipsoid, IKI–, CB–,
(2.7–)2.9–3.3(–3.7) × (1.8–)1.9–2.1(–2.2) µm,
L = 2.97 µm, W = 1.90 µm, Q = 1.56 (n=30/1).
7. On brown rot wood decayed by *Fomitopsis pinicola;* basidiocarps mostly < 5 cm in longest dimension, pores 4–5 per mm; basidiospores usually without guttules, > 2.1 µm in width . . . . *A. citrinella*
Frb. annual, resupinate or effused-reflexed; pore surface cream coloured to citric yellow, pores 4–5 per mm; tramal hyphae interwoven, basidiospores broadly ellipsoid, IKI–, CB–,
(2.9–)3–3.9(–4) × (2–)2.1–2.9(–3) µm,
L = 3.55 µm, W = 2.38 µm, Q = 1.49 (n=30/1).

8. Basidiocarps resupinate; cystidia present, basidiospores > 2 µm in width . . . . . .
. . . . *A. albocinnamomea*

Frb. annual, resupinate; pore surface cream to cinnamon coloured, pores 3–5 per mm; tramal hyphae interwoven, pyriform cystidia present, basidiospores oblong-ellipsoid, IKI–, CB–,

(3–)3.7–5(–5.5) × (2–)2.1–2.9(–3.3) µm,
L = 4.18 µm, W = 2.38 µm, Q = 1.61–1.84 (n=183/6).

8. Basidiocarps resupinate or effused-reflexed; cystidia absent, basidiospores < 2 µm in width . . . . *A. ussurii* Y.C. Dai & Niemelä

Frb. annual, pileate or effused-reflexed, upper surface pale tan to brownish; pore surface cream coloured to pale buff, pores 6–8 per mm; tramal hyphae interwoven, basidiospores oblong-ellipsoid, IKI–, CB–,

(2.9–)3–4(–4.7) × (1.1–)1.2–2(–2.1) µm,
L = 3.50 µm, W = 1.54 µm, Q = 2.17–2.54 (n=260/8).

9. On gymnosperms; subulate cystidia present . . . .
. . . . *A. gypsea* (Yasuda) T. Hattori & Ryvarden

Frb. annual to perennial, resupinate to effused-reflexed or pileate, upper surface cream coloured to pale greyish; pore surface white to cream coloured, pores 6–8 per mm; tramal hyphae interwoven, subulate cystidia present, basidiospores oblong-ellipsoid, IKI–, CB–,

(2.5–)2.6–3(–3.1) × 1.2–1.7(–1.8) µm,
L = 2.90 µm, W = 1.37 µm, Q = 2.11 (n=30/1).

9. On angiosperms; cystidia absent 10

10. Basidiocarps usually pileate, occasionally effused-reflexed . . . .
. . . . *A.* cf. *semisupina* (Berk. & M.A. Curtis) Ryvarden

Frb. annual, pileate, upper surface and pore surface cream coloured, pores 6–8 per mm; tramal hyphae interwoven, basidiospores ellipsoid, IKI–, CB–,

(2.5–)2.8–3.8(–4) × (1.7–)1.9–2.5 µm,
L = 3.13 µm, W = 2.10 µm, Q = 1.49–1.50 (n=60/2).

10. Basidiocarps usually resupinate, occasionally effused-reflexed 11

11. Basidiocarps not associated with *Hymenochaetaceae,* pores 4–5 per mm . . . . . .
. . . . *A. romellii* (Donk) Niemelä

Frb. annual, resupinate; pore surface cream to pale straw coloured, pores 4–5 per mm; tramal hyphae interwoven, basidiospores broadly ellipsoid, IKI–, CB–,

(3.3–)3.5–4(–4.1) × (2–)2.1–2.7(–2.9) µm,
L = 3.85 µm, W = 2.35 µm, Q = 1.64 (n=30/1).

11. Basidiocarps usually associated with species of *Hymenochaetaceae,* pores 7–9 per mm . . . . *A.micra*

Frb. annual, resupinate or effused-reflexed; pore surface snow white when fresh, ochraceous when dry, pores 7–9 per mm; tramal hyphae interwoven, basidiospores broadly ellipsoid, IKI–, CB–,

(2.7–)2.9–3.5 (–3.8) × (1.7–)1.9–2.2(–2.3) µm,
L = 3.12 µm, W = 2.05 µm, Q=1.48–1.57 (n=60/2).

Description

Antrodiella micra Y.C. Dai, *sp. nov.* (Figs.1-2)

Carpophorum annuum, resupinatum vel pileatum, contextum cremeum. Facies pororum cremea; pori 7–9 per mm. Systema hypharum dimiticum, hyphae generatoriae fibulatae, hyphae skeletales subiculi 3.1–4.4 µm in diam. Sporae perlato-ellipsoideae, 2.9–3.5 x 1.9–2.2 µm.

Type: China. Jilin Prov., Antu County, Changbaishan Nat. Res., rotten wood of *Populus*, associated with *Phellinus gilvus* (Schwein.:Fr.) Pat., 19.IX.1998 *Dai 2998, Niemelä & Qin* (holotype in IFP, isotype in H).

Etymology. — *micra* (Lat.): referring to small pores.

Fruitbody. — Basidiocarps annual, mostly resupinate, easily detachable, at first emerging as small patches which fuse together with age, resupinate part up to 25 cm long or more in longest dimension and 6 cm wide, when fresh elastic tough, without odour or taste, when dry becoming corky. Pileus projecting up to 3 mm, 2 cm wide, and 0.5 mm thick. Pileal surface cream, azonate, smooth; margin acute, curving down upon drying. Pore surface snow white when fresh, becoming pale buff when bruised, and pale ochraceous when dry; margin cottony, cream coloured to white, up to 1 mm wide; pores round, (6–)7–9 per mm (n=50/2), dissepiments thin, even to slightly lacerate. Context cream, corky, ca. 0.2 mm thick. Tubes cream, ca. 0.3 mm long.

Hyphal structure. — Hyphal system dimitic, generative hyphae bearing clamp connections, skeletal hyphae dominant, all the hyphae IKI–, CB+, and unchanged in KOH.

Context. — Generative hyphae hyaline, thin-walled, frequently with clamp connections and branched, (1.8–)2–3.6(–4.2) µm in diam (n=30/1); skeletal hyphae thick-walled with a medium or narrow lumen, flexuous, unbranched, agglutinated, (2.7–)3.1–4.4(–4.7) µm in diam (n=30/1).

Tubes. — Tramal hyphae similar to those in context but slightly thinner, skeletal hyphae usually with a lumen, interwoven, more or less agglutinated. Cystidia and cystidioles absent; basidia barrel-shaped, bearing four sterigmata and a basal clamp, (8–)9–11(–12) × (3.5–)4–5(–5.5) µm (n=28/1); basidioles in shape similar to basidia, but slightly smaller. Rhomboid crystals present.

Spores. — Basidiospores broadly ellipsoid, hyaline, thin-walled, smooth, IKI–, CB–, (2.7–)2.9–3.5(–3.8) × (1.7–)1.9–2.2(–2.3) µm, L = 3.12 µm, W = 2.05 µm, Q=1.48–1.57 (n=60/2).

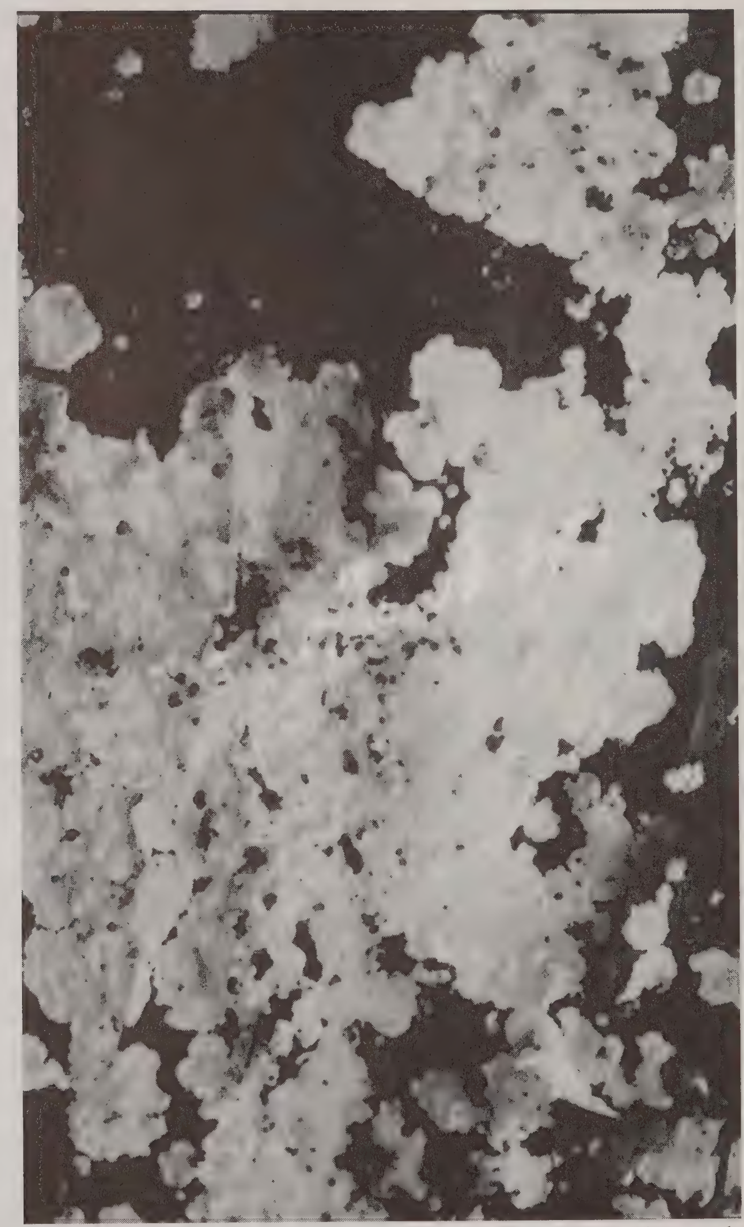

Fig. 1. *Antrodiella micra*. A fresh basidiocarp, specimen Dai 2998. Photograph Y.C. Dai in situ, × 0.6.

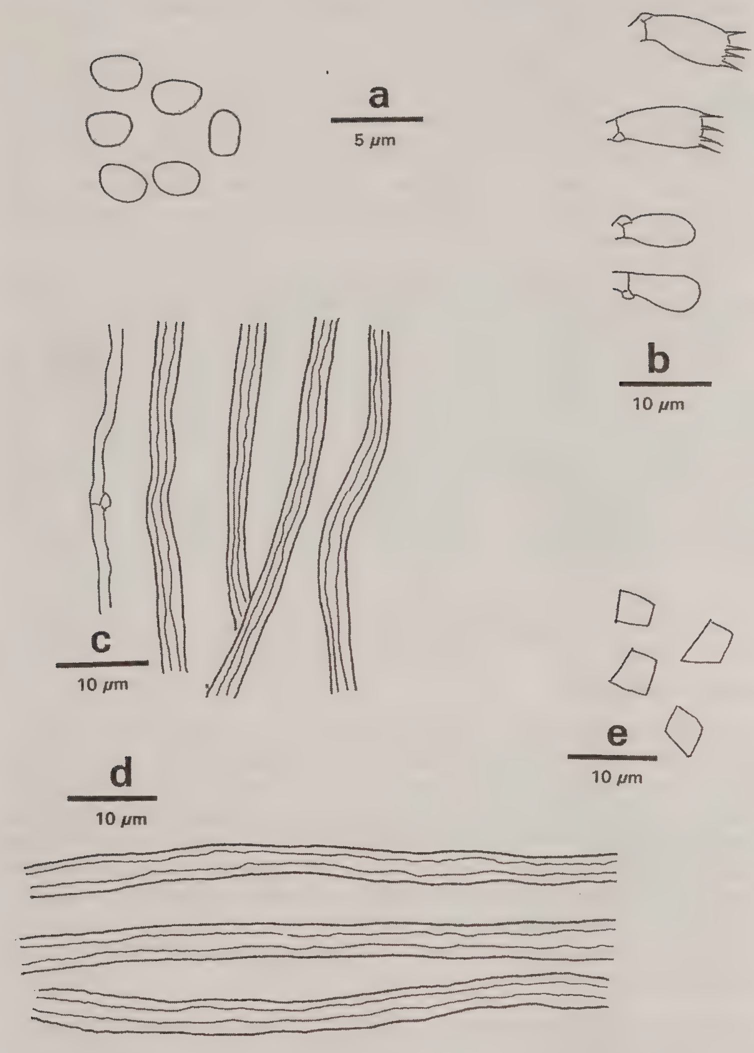
a
5 µm
b
10 µm
c
10 µm
e
10 µm
d
10 µm

Fig. 2. Anatomical details of *Antrodiella micra* (drawn from the holotype). — a: Basidiospores. — b: Basidia and basidioles. — c: Generative hyphae and skeletal hyphae from trama. — d: Skeletal hyphae from subiculum. — e: Rhomboid crystals

Additional specimen (paratype) examined. — China. Jilin Prov., Fusong County, Shuguang, rotten wood of *Acer* decayed by *Hymenochaete* sp., 21.VII.1993 *Dai 632* (IFP).

The resupinate or effused-reflexed basidiocarps of *Antrodiella micra* have a snow white pore surface, and small pores and spores. It resembles *A. pallasii*, but that species has pale yellowish or sordid cream coloured pores when fresh, and its pores are somewhat larger (6–7 per mm). In addition, *A. pallasii* grows mostly on rotten spruce wood decayed by *Trichaptum abietinum* (Pers.:Fr.) Ryvarden, while the new species grows on wood of angiosperm trees decayed by species of the *Hymenochaetaceae*.

Antrodiella micra is closely related to the species of the *A. romellii* complex, which however have larger pores (4–5 per mm) and bigger basidiospores (3.5–4 × 2.1–2.7 µm), and are not associated with the *Hymenochaetaceae*. Four taxa related to *A. semisupina* have recently been published from Europe and North America (Vampola & Pouzar 1996): *A. faginea* Vampola & Pouzar, *A. thompsonii* Vampola & Pouzar, *A. beschidica* Vampola & Pouzar, and *A. farinacea* Vampola & Pouzar. The first two differ from *A. micra* by having gloeocystidia. *A. beschidica* distinguishes from *A. micra* by its imbricate basidiocarps, somewhat larger pores (5–7 per mm), and oblong-ellipsoid basidiospores. In addition, it grows on *Abies*. Pore size and dimensions of basidiospores of *A. farinacea* are similar to those of *A. micra,* but the spores of *A. farinacea* are curved, dinstinctly tapering at apiculus.

Notes on some other species

Antrodiella liebmannii

A. liebmannii has stipitate basidiocarps, and its upper surface is chestnut to deep bay coloured, making it unusual in the genus of *Antrodiella*. However, it has a dimitic hyphal system, with the generative hyphae bearing clamp connections. Hyphae are strongly agglutinated and cyanophilous. In addition, its basidiospores are small and ellipsoid, hyaline, thin-walled, and negative in Melzer's reagent and Cotton Blue, making it a characteristic species of *Antrodiella*. The spores in the Chinese specimens are longer and narrower than those reported from East Africa (2.8–3.8 × 1.5–2 µm vs. 2–3 × 2–2.5 µm, Ryvarden & Johansen 1980).

Antrodiella zonata

There is a confusion concerning the identity of *A. zonata*, because at least five names (*Irpex cingulatus* Lloyd 1918, *I. consors* Berk. 1877, *I. decurrens* Berk. ex Cooke 1891, *Daedalea gollanii* Maas Geest. 1908 and *I. zonatus* Berk. 1854) are associated with the complex, and most collections are sterile. Cunningham (1965) believed that all the names refer to a single species, while Maas Geesteranus (1974) thought they represented different taxa. Ryvarden (1992) merged all the five species together, and proposed the new combination *A. zonata* based on the priority of *Irpex zonatus*. *I. zonatus* was described on material from Nepal and Sri Lanka, which are geographically close to my material from Hainan, Yunnan, Guizhou, Sichuan and Hunan. The Chinese specimens are fertile, and the basidiospores are ellipsoid to oblong-ellipsoid, (3.8–)4.2–6(–6.5) × (2.7–)3–4(–4.3) µm, L = 5.10 µm, W = 3.52 µm, Q = 1.44–1.46 (n=60/2). *A. zonata* was also reported from Zhejiang Province, East China (Hattori & Zang 1995), and that material is identical to my specimens. Therefore I believe that all the Chinese collections belong to *A. zonata*. When fresh *A. zonata* has pale yellow to yellowish brown basidiocarps, which become brownish when bruised.

Specimens examined. — *A. aurantilaeta*. China. Guangxi-zhuangzu Auto. Reg., Longlin County, rotten bamboo, 21.X.1957 *Xu 175* (HMAS 28367). Jundong County, rotten wood, 13.VIII.1957 *Xu 1205* (HMAS 28365). Hunan Prov., Sanzhi County, Badagongshan Nat. Res., rotten wood of *Davidia*, 26.IX.1999 *Härkönen 357* (H). Japan. Ibaraki, Kitaibaraki, Ogawa, 25.IX.1989 *Hattori* (TFM-F 15154). — *A. liebmannii*. China. Hainan Prov., Tingan, 31.VIII.1934 *Teng 4001* (BPI 221375), 22.XII.1934 *Teng 8081* (BPI 221590). — *A. pallasii*. China. Heilongjiang Prov., Yichun, Fenglin Nat. Res., rotten *Picea* decayed by *Trichaptum,* 9.IX.2002 *Dai 3717* (IFP). Jilin Prov., Huinan County, Hongqi, rotten wood of *Picea,* 12.X.1993 *Dai 1555b* (IFP). Russia, Bashkortostan, Uchaly Dist., Ikhsanovo, Verkhne-Belskoe, fallen trunk of *Picea,* 23.VIII.2001 *Dai 3323* (H). — *A. romellii*. China. Jilin Prov., Antu County, Changbaishan Nat. Res., fallen branch of *Acer,* 20.IX.2002 *Dai 3867* (IFP). Russia. Siberia, *Betula*, IX.1934 *Krawtzew 115* (PRM 811661). — *A. zonata*. China. Guizhou Province, Shuiyang County, Wangcao, Kuankuoshui Nat. Res., fallen trunk of *Quercus*, 17.VI.2000 *Dai 3220* (IFP). Hainan Prov., Lingshui County, Diaoluoshan Nat. Res., fallen branch of angiosperm, 23.XI.2002 *Dai 4481* (IFP). Hunan Province, Changsha, Yuelushan Park, on dead tree of *Liquidambar*, 20.XII.2000 *Dai 3252* (IFP, H). Sichuan Prov., Emei County, Emei Mts., dead angiosperm tree, 20.X.2002 *Dai 4317* (IFP). Zhejiang Prov., Baishazushan, 23.VII.1994 *Abe* (TNS).

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Literature cited

Brummitt PK, Powell CE. 1992. Authors of plant names. Royal Botanic Gardens, Kew, UK.

Cunningham GH. 1965. *Polyporaceae* of New Zealand. Bull. New Zealand Depart. Sci. Indust. Res. 164: 1–304.

Dai YC, Niemelä T. 1997. Changbai wood-rotting fungi 6. Study on *Antrodiella*, two new species and notices on some other species. Mycotaxon 64: 67–81.

Hattori T, Ryvarden L. 1993. *Antrodiella aurantilaeta* (*Polyporaceae,* Basidiomycotina), a new polypore to Japan. Trans. Mycol. Soc. Japan 34: 363–368.

Hattori T, Zang M. 1995. List of polypores collected in East China. Bull. Nat. Sci. Mus., Series B 21: 95–105.

Johannesson H, Renvall P, Stenlid J. 2000. Taxonomy of *Antrodiella* inferred from morphological and molecular data. Mycol. Res. 104: 92–99.

Maas Geesteranus RA. 1974. Studies in the genera *Irpex* and *Steccherinum*. Persoonia 7: 443–581.

Núñez M, Ryvarden L. 2001. East Asian polypores 2. *Polyporaceae s. lato*. Synopsis Fungorum 14: 170–522.

Ryvarden, L. 1992: On Irpex zonatus. — Bol. Soc. Argent. Bot. 28: 227–231.

Ryvarden L, Gilbertson RL. 1993. European polypores 1. *Abortiporus - Lindtneria*. Synopsis Fungorum 6: 1–387.

Ryvarden L, Johansen I. 1980. The preliminary polypore flora of East Africa. Fungiflora, Oslo, Norway.

Vampola P. 1991. *Antrodiella parasitica,* a new species of polypores. Česká Mykol. 45: 10–14.

Vampola P, Pouzar Z. 1996. Contribution to the knowledge of the central European species of the genus *Antrodiella*. Czech Mycol. 49: 21–33.

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New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa III. *Marasmius* sect. *Sicci*

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Abstract– Twelve new tropical African taxa of *Marasmius* sect. *Sicci (M. confertus* var. *tenuicystidiatus, M. confertus* var. *parvisporus, M. ferruginacies, M. ferruginoides, M. longistipitatus, M. pseudotorquescens, M. rammelooi, M. robertsii, M. rubro-stipitatus, M. striaepileus, M. tanougouensis, M. xestocephaloides)* are described and briefly discussed.

Key words– *Agaricales,* new taxa, taxonomy, nomenclature

Introduction

This paper represents the third part of a series of descriptions of new taxa of marasmioid genera from the tropical Africa (Antonín 2003a, b). All of the taxa described here belong to the richest and most complicated section, sect. *Sicci*. The complete study of these genera will be published in a series of monographs titled „Flore illustrée des champignons d´Afrique centrale“ published by the National Botanical Garden in Meise (Belgium) in 2004. For material and methods see Antonín (2003a).

Species descriptions

Marasmius confertus Berk. & Broome var. _tenuicystidiatus_ Antonín var. nov. Figure 1

A varietate typica pileo solum marginem leviter striato, pleurocystidiis raris, angustis (25–45(–55) x 7,0–10 µm) et projectionibus crassitunicatis differt.
Holotypus: Cameroon, Provincia Sud, Somalomo, area biosphaerica protecta Dja, 8. IV. 2001 leg. V. Antonín Cm 01.41 (holotypus in herbario BRNM 666109 asservatur).

Macroscopically almost identical with the type variety, but differing by having an only slightly at margin striate pileus, scattered, shorter and narrower pleurocystidia (25–45(–55) x 7.0–10 μm) and by the absence of distinctly thick-walled pileipellis broom cells with less numerous and longer projections.

Ecology – Saprophytic, growing on dead leaves.

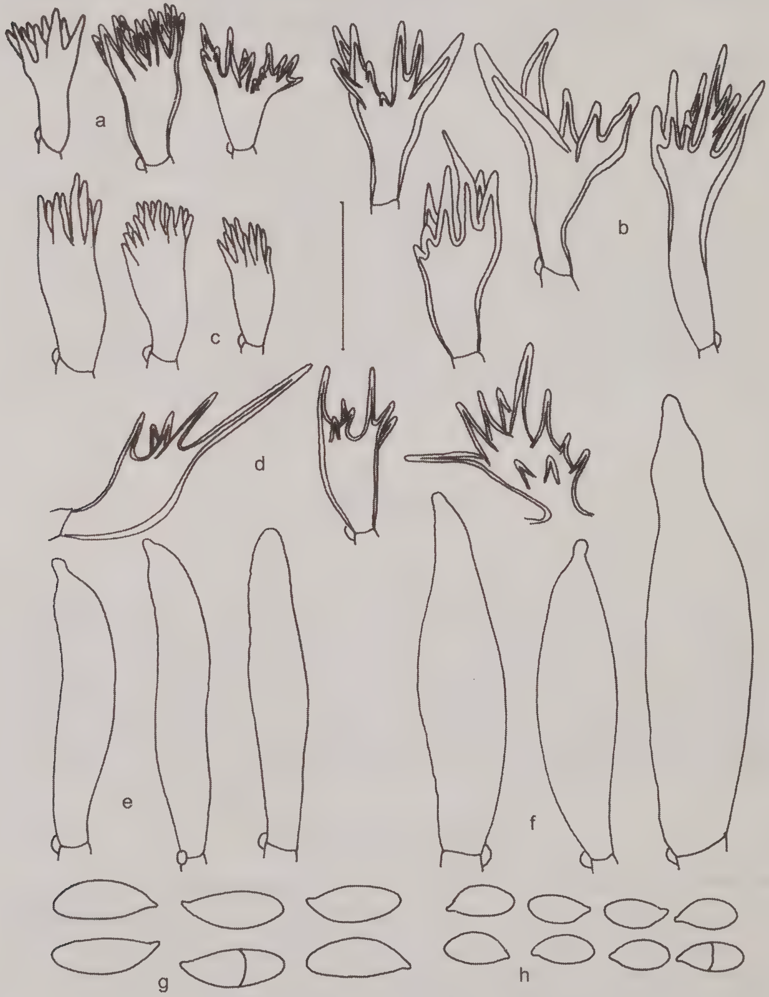

Figure 1. *Marasmius confertus*: a. and b. pileipellis cells, c. cheilocystidia, d. caulocystidia, e. pleurocystidia of var. *tenuicystidiatus* (holotype), f. pleurocystidia of var. *confertus*, g. basidiospores of var. *confertus*, h. basidiospores of var. *parvisporus* (holotype). Scale bar = 20 μm.

Distribution – So far known only from Burundi, Cameroon and the Democratic Republic of Congo.

REVISED SPECIMENS – BURUNDI: Bururi Province, Kigwena, Forêt de Kigwena, 22 Feb. 1979 leg. J. Rammeloo 6722 (BR 11951-20). – **CAMEROON:** Sud Province, Somalomo, Dja Biosphere Reserve, 8 Apr. 2001 leg. V. Antonín Cm 01.41 (holotype, BRNM 666109). – Ditto, 12 Apr. 2001 leg. V. Antonín Cm 01.103 (BRNM 666151). – **DEMOCRATIC REPUBLIC OF CONGO:** Tshopo Province, Kisangani, 2 May 1984 leg. B. Buyck 1614 (BR 11732-92). – Katanga Province, Plateau de Biano, 29 July 1986 leg. J. Rammeloo 8779 (BR 1255-91). – Katanga Province, Plateau de Biano, 12 Jan. 1987 leg. J. Rammeloo 8781 (BR 1261-00).

Marasmius confertus Berk. & Broome var. *parvisporus* Antonín var. nov. Figure 1

A varietate typica basidiosporis brevibus (7,3–10 x 3,6–4,6 μm) differt.
Holotypus: Kenya, Provincia Central, Districtus Nairobi, Thika, cataracta Thika, 16. III. 1968 leg. D.N. Pegler K101 (holotypus in herbario K asservatur).

Differs from the type variety by having distinctly smaller, 7.3–10 x 3.6–4.6 μm large basidiospores (E = 1.7–2.3, Q = 2.0–2.1).

Ecology – Saprophytic, growing on dead fallen twigs.

Distribution – So far known from the Democratic Republic of Congo, Kenya and Uganda.

REVISED SPECIMENS – DEMOCRATIC REPUBLIC OF CONGO: Katanga Province, Kakombwe, 27 March 1986 leg. J. Schreurs 1525 (BR 8287-42). – **KENYA:** Central Province, Nairobi District, Thika, Thika Fall, 16 March 1968 leg. D.N. Pegler K101 (holotype, K, as *M. corrugatiformis*). – **UGANDA:** Buganda Province, Mengo District, Mawacota County, Mpanga Research Forest, 7 June 1968 leg. D.N. Pegler U1252 (K, as *M. corrugatiformis*).

Marasmius ferruginacies Antonín sp. nov. Figure 2

Pileo 30 mm lato, convexo, umbilicato et papillato, sulcato-striato, brunneo-rubro vel rubro-brunneo. Lamellis distatibus, L = 22, intervenosis, luteolo-albidis, acie ferrugineis. Stipite 75 x 0,75 mm, filiforme, glabro, apicem luteolo-albido, ad basim obscure brunneo. Basidiosporis 9,0–12 x 5,0–6,0 μm, ellipsoideis, fusiformis-ellipsoideis vel subamygdaliformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 17–22 x 8,0–10,0 μm, clavatis vel subcylindraceis, tenuitunicatis vel leviter crassitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 15–29 x 6,0–15 μm, clavatis vel subcylindraceis, tenuitunicatis vel leviter crassitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad ramulos putridos.

Holotypus: Cameroon, area biosphaerica protecta Dja, prope Somalomo, 9. IV. 2001 leg. V. Antonín Cm01.59 (holotypus in herbario BRNM 666127 asservatur).

Carpophores single. **Pileus** 30 mm broad, convex, with slightly depressed centre and small broad papilla in depression, crenulate at margin, sulcate-striate, slightly tomentose, entirely brownish red to reddish brown (9C–D7), slightly darker at centre. **Lamellae** distant, L = 22, l = 0–1, forming a pseudocollarium, intervenose, broad (up to 4 mm), yellowish white (3–4A2), with ferrugineous, pubescent edge. **Stipe** 75 x 0.75 mm, filiform, hollow, slightly broadened at apex, non-insititious, smooth, glabrous, yellowish white (± concolorous with lamellae at apex), dark brown (8F8) towards base; rhizomorphs well-developed.

Basidiospores 9.0–12 x 5.0–6.0 μm, E = 1.3–2.2, Q = 1.9, ellipsoid, fusoid-ellipsoid to subamygdaliform, thin-walled, hyaline, nondextrinoid. **Basidia** 4-spored, clavate. **Basidioles** 15–32 x 4.0–9.0 μm, cylindrical, clavate or subfusoid. **Cheilocystidia** in the form of broom cells of the Siccus-type, 17–22 x 8.0–10 μm, clavate to subcylindrical, thin- to slightly thick-walled, nondextrinoid, similar to pileipellis cells. **Pleurocystidia** absent. **Trama hyphae** cylindrical to subinflated, ± thin-walled, hyaline, dextrinoid, up to 15 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 15–29 x 6.0–15 μm, clavate or subcylindrical, thin- or less frequently slightly thick-walled below, slightly thick-walled above, nondextrinoid, with 7–15 short and wide, obtuse, thick-walled, up to 9.0 x 3.0 μm projections; thick-walled parts ochraceous yellow in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled (up to 1.0 μm), nondextrinoid hyphae with ochraceous brown walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on fallen twigs.

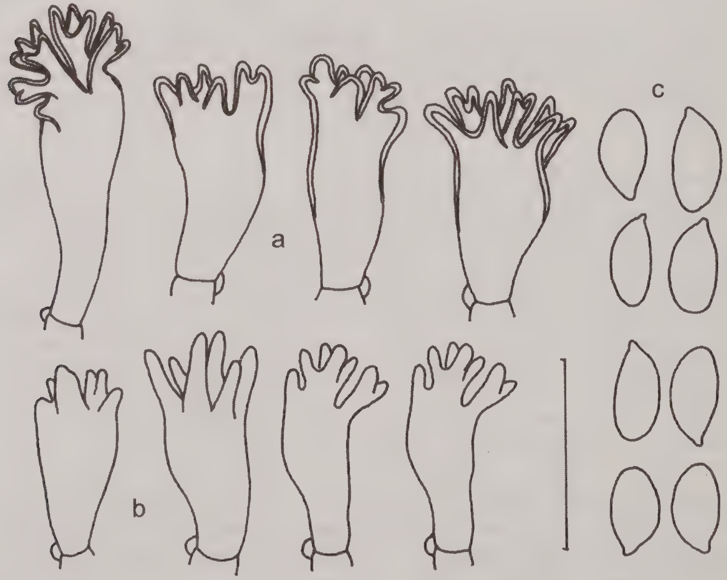

Figure 2. *Marasmius ferruginacies* (holotype): a. pileipellis cells, b. cheilocystidia, c. basidiospores. Scale bar = 20 μm.

REVISED SPECIMENS – CAMEROON: Dja Biosphere Reserve, c. 14 km ESE of Somalomo, 9 Apr. 2001 leg. V. Antonín Cm01.59 (holotype, BRNM 666127).

Comments – *Marasmius ferruginacies* is characterised by having a moderately large, ± uniformly brownish red to reddish brown coloured pileus, distant lamellae with coloured edge, a thin, dark brown stipe, small, ellipsoid, fusoid-ellipsoid to subamygdaliform basidiospores, and cheilocystidia and pileipellis broom cells with short and wide projections.

A very close species, both macro- and microscopically, is *M. nodulocystis* Pegler. It differs in having well-developed rhizomorphs, a ferrugineous lamellar edge, and slightly smaller and distinctly narrower basidiospores (7.5–10.5 x 3.5–4.4 μm). Compared with it, *Marasmius floriceps* Berk. & M.A. Curtis has a smaller pileus (10–17 mm), more distant lamellae (14–18), a shorter (25–35 mm), red-brown stipe and smaller basidiospores (7–10 x 3.5–4 μm) (Desjardin & Horak 1997). *Marasmius pusio* Berk. & M.A. Curtis is a small fungus with a non-striate, only 4–10 mm broad, ochre-, apricot- or orangish brown pileus, more distant lamellae (10–13), well-developed lamellulae, a small (7–18 x 0.5–0.8 mm), pale orangish brown stipe, smaller basidiospores (8–10.5 x 3.5–4.5 μm) and different (narrow and long) projections of pileipellis broom cells (Desjardin & Horak 1997, Singer 1976). *Marasmius corrugatus* (Pat.) Sacc. & P. Syd. has a reddish cinnamon to chestnut brown pileus, concolorous lamellar edges, a more robust stipe (25–35 x 1–2.5 mm), narrower basidiospores (9–13 x 2.7–4 μm) and narrow and acute projections of cheilocystidia and pileipellis broom cells (Pegler 1983); *M. florideus* Berk. & Broome has a smaller pileus (10–20 mm), a more robust (30–55 x 1–2 mm), reddish brown stipe, smaller basidiospores (8–10 x 3–3.5 μm), smaller basidia (14–18 x 4–5 μm) and smaller cheilocystidia and pileipellis broom cells with only 3–5 acute projections (Pegler 1986); *M. bezerrae* Singer has a smaller pileus (7–17 mm), a shorter stipe (35–50 x 0.6–1 mm), smaller basidiospores ((8–)9–11 x 3.2–5.4 μm) and spinulose projections of pileipellis broom cells (Singer (1976)).

Marasmius ferruginoides Antonín sp. nov. **Figure 3**

Pileo 5–20 mm lato, campanulato vel late campanulato, leviter striato, obscure luteo, luteolo-aurantiaco vel aurantiaco. Lamellis, L = 18–21, liberis, luteolo-albidis. Stipite 30–65 x ± 1 mm, cylindraceo, glabro, apicem pallido, ad basim nigro-brunneo. Basidiosporis 11,5–14 x 3,8–5,2 μm, fusiformibus, clavato-fusiformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, (10–)13–19 x 6,2–8,1 μm, clavatis vel subcylindraceis, tenuitunicatis. Pleurocystidiis 27–42 x 6.2–9.0 μm, subcylindraceis, subfusiformibus, rostratis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 8,5–14 x 3,8–7,7 μm, clavatis vel subcylindraceis, tenuitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad folia putrida.

Holotypus: Democratic Republic of Congo, Provincia Tshopo, Kisangani, silva prope hortum animalium, 2. V. 1984 leg. B. Buyck 1615 (holotypus in herbario BR 11731-91 asservatur).

Misapplied name: *Marasmius gardneri* Singer s. Pegler, Kew Bull. Addit. Ser. 6: 194. 1977.

Pileus 5–20 mm broad, campanulate, then broadly campanulate with reflexed margin, smooth, finely tomentose, slightly striate almost to centre, deep yellow, yellowish orange (4A7–8, 4B7–8) or orange. **Lamellae** close, L = 18–21, l = 2–3, free, with concolorous edge. **Stipe** 30–65 x ± 1 mm, cylindrical, laterally compressed, smooth, glabrous, lustrous, black-brown, with paler apex, with rusty brown, woolly basal mycelium.

Basidiospores 11.5–14 x 3.8–5.2 μm, E = 2.4–2.9, Q = 2.6, (sub)fusoid, clavate-fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** 4-spored, clavate. **Basidioles** 10–29 x 4.5–8.5 μm, cylindrical, clavate, fusoid. **Cheilocystidia** in the form of broom cells of the Siccus-type, (10–)13–19 x 6.2–8.1 μm, clavate to subcylindrical, thin-walled, nondextrinoid, with obtuse to subacute, slightly thick-walled projections. **Pleurocystidia** 27–42 x 6.2–9.0 μm, subcylindrical, subfusoid, rostrate, thin-walled, nondextrinoid, with slightly refractive contents. **Trama hyphae** cylindrical to subinflated, thin- to slightly thick-walled, smooth to finely incrusted (subpileipellis), hyaline, dextrinoid, up to 18 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 8.5–14 x 3.8–7.7 μm, clavate to subcylindrical, entirely thin-walled or with slightly thick-walled apex, nondextrinoid, with 15–30 digitate, obtuse to subacute, sometimes acute, slightly nodulose, up to 6.5 x 0.8(–1.5) μm projections; thick-walled parts pale yellow-brown in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 5.0 μm wide hyphae, with brownish yellow walls. **Caulocystidia** absent. **Clamp connections** present in all tissues.

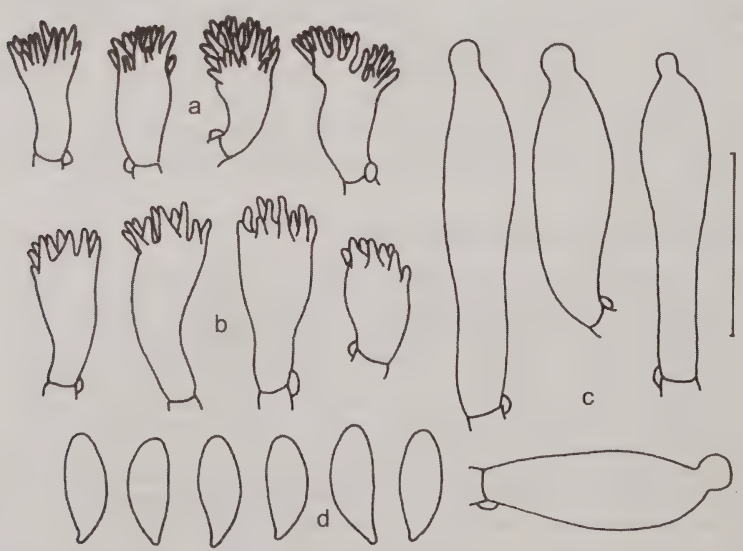

Figure 3. *Marasmius ferruginoides* (holotype): a. pileipellis cells, b. cheilocystidia, c. pleurocystidia, d. basidiospores. Scale bar = 20 μm.

Ecology – Saprophytic, growing on fallen leaves, rarely on strongly decayed wood.

Distribution – So far known from Cameroon, Democratic Republic of Congo, Ghana, Kenya and Nigeria.

REVISED SPECIMENS – CAMEROON: South West Province, Korup National Park, trail to Erat, 2 May 1996 leg. P.J. Roberts K360 (K(M) 39230, as *M. gardneri*). – Ditto, 25 Apr. 1996 leg. P.J. Roberts K51 (K(M) 39484, as *M. gardneri*). – **DEMOCRATIC REPUBLIC OF CONGO:** Tshopo Province, Kisangani, forest near ZOO, 2 May 1984 leg. B. Buyck 1615 (holotype, BR 11731-91). – **GHANA:** Cape Coast, University College, 12 June 1971 leg. A.C. Rose CC7131 (K, as *M. gardneri*). – **KENYA:** Central Province, Nairobi District, Nairobi, City Park, 12 March 1968 leg. D.N. Pegler K11 (K, as *M. gardneri*). – **NIGERIA:** Akwa Ibom State, Ekpere Obam, 12 May 1990 leg. R.A. Nicholson 438 (K(M) 16693, as *M. ferrugineus*). – Cross River State, Aking, Oban Forest, 19 June 1990 leg. R.A. Nicholson (K(M) 16707, as *M. ferrugineus*). – Cross River State, Anua Ravine, 4 June 1990 leg. R.A. Nicholson 486 (K(M) 16860, as *M. ferrugineus*). – Ditto, 13 May 1989 leg. R.A. Nicholson 199 (K(M) 7591, as *M. gardneri*). – Cross River State, Obudu Ranch, 24 Apr. 1989 leg. R.A. Nicholson 174 (K(M) 5388, as *M. gardneri*). – Cross River State, Uyo, Anua Ravine, 6 June 1990 leg. R.A. Nicholson 508 (K(M) 17070, as *M. sierraleonis*).

Comments – *Marasmius ferruginoides* is characterised by having a campanulate to broadly campanulate, deep yellow to (yellowish) orange pileus, close lamellae, a black-brown stipe, rather small, (sub)fusoid, clavate-fusoid basidiospores, well-developed narrow pleurocystidia and lacking caulocystidia.

This species was published from Africa as *Marasmius gardneri* Singer by Pegler (1977). However, the revision of the type specimen (Brazil, Minas Gerais, leg. Gardner, K(M) 92652) showed that the true *Marasmius ferrugineus* (Berk.) Berk. & M.A. Curtis (= *M. gardneri*) has a smaller, 2–10 mm broad, fulvous-ferrugineous, light orange to greyish orange pileus and distinctly longer basidiospores (18–22 x 4.0–5.5–6.0) μm).

Among African species, *Marasmius confertus* Berk. & Broome has a brown, orange or brownish orange pileus and larger pleurocystidia (25–60(–75) x 10–16(–20) μm).

Marasmius dennisii Singer has a distinctly larger, 15–50 mm broad, orange-chrome to ochraceous orange pileus, and larger basidiospores (12.5–17 x 3–4 μm and 14–17 x 3–3.5 μm, respectively, Dennis 1951, 1970, Pegler 1983, Singer 1976). *Marasmius nocturnus* Har. Takahashi has a light yellow, reddish yellow, light orange to orange, later brown pileus, smaller basidiospores (9–10.5 x 4–4.5 μm), very narrow pleurocystidia (25–45 x 4–6 μm) and large pileipellis broom cells (20–28.5 x 5–12 μm) (Takahashi 2000).

Marasmius longistipitatus Antonín sp. nov. Figure 4

Pileo 1–10 mm lato, junio subhaemisphaerico, papillato, dein convexo, leviter umbonato et papillato, striato, centro pallide griseo-aurantiaco, marginem aurantiaco-albido. Lamellis, L = 9–12, adnatis, albido-luteolis. Stipite 20–150 x 0,3–0,6 mm, cylindraceo, apicem pallide luteo, ad basim rubro-aurantiaco vel brunneo-aurantiaco. Basidiosporis (17–)20–28 x 4.5–6.0 μm, clavatis, clavato-

fusiformibus, cylindrice-clavatis, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 12–18 x 6,0–9,0 µm, clavatis vel subcylindraceis, tenuitunicatis. Pleurocystidiis 35–68 x 6.0–9.0 µm, cylindraceis, anguste clavatis, anguste fusiformibus, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii sicci, 11–18 x (4,0–)6,0–9,0 µm, clavatis vel subcylindraceis, leviter crassitunicatis vel ad basim tenuitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad folia putrida.

HOLOTYPUS: Benin, Provincia Atacora, Tanougou, cataracta Tanougou, 8. IX. 1997 leg. V. Antonín B97.172 (holotypus in herbario BR 101210-39 asservatur).

Pileus 1–10 mm broad, almost hemispherical when young, then convex, with a pronounced conical papilla when young, with rugulose and slightly papillate centre in small central depression when old, translucently striate, with crenulate and slightly inflexed margin, sulcate, slightly tomentose, pale greyish orange (6B6) at centre, pallescent up to orange-white (5A2, sometimes even more whitish) towards margin. **Lamellae** distant, L = 9–12, l = 0–1, adnate to a pseudocollarium, rather thick, not intervenose, white-yellowish (2-3A2), then pale yellow (up to 4A3), with concolorous, entire, finely pubescent edge. **Stipe** very long and thin, 20–150 x 0.3–0.6 mm, cylindrical, slightly broadened at apex or not, smooth, slightly pruinose at apex, lustrous, often curved, except for cream or pale yellow (2–3A2 to 4A3) apex, entirely reddish orange to brownish orange (through 7B–C7) towards base; forming small abortive pilei on a long stipe.

Basidiospores (17–)20–28 x 4.5–6.0 µm, E = 4.0–5.4, Q = 4.5, clavate, fusoid-clavate, cylindrical-clavate, hyaline, nondextrinoid, thin-walled. **Basidia** 35 x 12 µm (only one found), 4-spored, (broadly) clavate. **Basidioles** 16–35 x 4.0–13 µm, (broadly) clavate, subfusoid, cylindrical. **Cheilocystidia** in the form of broom cells of the Siccus-type, 12–18 x 6.0–9.0 µm, clavate to subcylindrical, thin-walled, hyaline, nondextrinoid, with nodulose, obtuse to subacute, slightly thick-walled, up to 5.0 x 1.0 µm large projections. **Pleurocystidia** 35–68 x 6.0–9.0 µm, cylindrical, narrowly clavate, narrowly fusoid, often moniliform, often subcapitate, often branched above, thin-walled, nondextrinoid, with refractive contents. **Trama hyphae** cylindrical, thin- to slightly thick-walled, smooth or minutely incrusted, hyaline, dextrinoid, up to 8.0 µm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 11–18 x (4.0-)6.0–9.0 µm, (sub)cylindrical to clavate, entirely slightly thick-walled or with thin-walled base, with 8–25(–30) nodulose, ± digitate, subacute to acute, slightly thick-walled, up to 5.0 x 1.0 µm large projections; thick-walled parts ochraceous yellow in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 6.0 µm wide hyphae, with ochraceous walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic on dead leaves, mostly on or near their veins.

Distribution – So far known only from the type locality in Benin.

REVISED SPECIMENS: BENIN: Atacora Province, Tanougou, Choutes de Tanougou, 8 Sept. 1997 leg. V. Antonín B97.172 (holotype, BR 101210-39).

Comments – *Marasmius longistipitatus* is a very distinct species characterised by having a small, papillate, pale greyish orange to orange-white pileus, distant lamellae, a very long and thin, reddish orange to brownish orange stipe, very long basidiospores, long and narrow pleurocystidia, and lacking caulocystidia.

The combination of a very long stipe with very large basidiospores is rather rare among *Marasmius* species. Only *Marasmius megistosporus* Singer has similar features. However, it has a larger, 35 mm broad, deep brown pileus at centre which turns through deep ferrugineous to gold brown towards margin, and even larger basidiospores (28–37.5 x 3.5–5.5 μm) (Singer 1976).

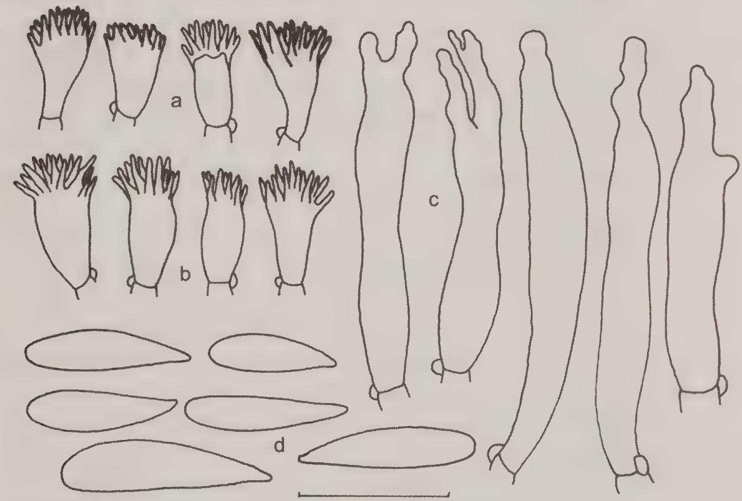

Figure 4. *Marasmius longistipitatus* (holotype): a. pileipellis cells, b. cheilocystidia, c. pleurocystidia, d. basidiospores. Scale bar = 20 μm.

Marasmius pseudotorquescens Antonín sp. nov. Figure 5

Pileo 17–29 mm lato, convexo, subumbonato, leviter striato, luteolo-brunneo, centro obscure brunneo. Lamellis, L = 18–20, liberis, luteolo-albidis. Stipite 60–70 x 1 mm, cylindraceo, subtiliter pruinoso vel pubescente, apicem griseo-aurantiaco, ad basim obscure brunneo. Basidiosporis (14–) 15–16(–17) x (4,0–)4,5–5,5(–6,0) μm, fusiformibus vel clavatis, hyalinis. Basidiis tetrasporis. Cheilocystidiis 25–55 x 8,0–12 μm, fusiformibus, (sub)cylindraceis, lageniformibus, rostratis, tenuitunicatis. Pleurocystidiis 41–82 x 12–18 μm, lageniformibus, fusiformibus, cylindraceis, clavatis, subutriformibus, rostratis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 8,0–12 x 6,5–9,0 μm, clavatis vel subcylindraceis, crassitunicatis vel ad basim tenuitunicatis. Pileosetis 32–70 x 6,0–8,0 μm, subuliformibus, lageniformibus, obtusis vel acutis, crassitunicatis, dextrinoideis. Caulocystidiis e cellulis similibus cellulis hymenodermatis Marasmii sicci et setiformibus, 35–60 x 7.0–12 μm, subuliformibus, fusiformibus, lageniformibus, subcylindraceis crassitunicatis. Hyphis fibulatis, *in stipite et trama dextrinoideis. Ad ramulos putridos.*

Holotypus: Democratic Republic of Congo, Irangi, Kivu, 17. IV. 1972 leg. J. Rammeloo JR Z316 (holotypus in herbario GENT asservatur).

Pileus 17–29 mm broad, convex, with small umbo, slightly radially striate, finely velvety, yellowish brown (5D5) with dark brown (7E–F6) centre. **Lamellae** rather close, L = 18–20, with lamellulae, free, not intervenose, yellowish white (4A2), with concolorous edge. **Stipe** 60–70 x 1 mm, cylindrical, finely pruinose to finely pubescent (lens), hollow, greyish orange (5B4) at apex, dark brown (7F5) towards base. **Context** without any distinct smell or taste.

Basidiospores (14–)15–16(–17) x (4.0–)4.5–5.5–6.0) μm, E = 2.5–3.7, Q = 2.9–3.1, fusoid to clavate, thin-walled, hyaline, nondextrinoid. **Basidia** 4-spored, clavate. **Basidioles** up to 30 x 9.0 μm, clavate, cylindrical, fusoid. **Cheilocystidia** 25–55 x 8.0–12 μm, versiform, fusoid, (sub)cylindrical, lageniform, often rostrate, often moniliform, thin-walled, never in the form of broom cells, nondextrinoid. **Pleurocystidia** 41–82 x 12–18 μm, versiform, lageniform, fusoid, cylindrical, clavate, subutriform, often rostrate, rostrum often moniliform, thin-walled, hyaline, nondextrinoid, with refractive contents. **Trama hyphae** cylindrical, subfusoid, ± thin-walled, hyaline, dextrinoid, up to 20 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 8.0–12 x 6.5–9.0 μm, subcylindrical to clavate, entirely thick-walled or thin-walled at base, with 6–20(–25) nodulose, digitate or conical, obtuse to subacute, up to 10 x 1.5 μm large projections. **Pileosetae** 32–70 x 6.0–8.0 μm, subulate, lageniform, obtuse to subacute, thick-walled, dextrinoid. **Stipitipellis** a cutis made up of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 5.0 μm wide hyphae with ochraceous-olivaceous walls in KOH. **Caulocystidia** in the form of setoid broom cells or setae, 35–60 x 7.0–12 μm, awl-form, fusoid, lageniform, subcylindrical, thick-walled (up to 1.5 μm) at least in upper part, concolorous with stipitipellis hyphae, nondextrinoid. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on dead twigs.

Distribution – Known only from the Democratic Republic of Congo.

REVISED SPECIMENS – DEMOCRATIC REPUBLIC OF CONGO: Irangi, Kivu, 17 Apr. 1972 leg. J. Rammeloo JR Z316 (holotype, GENT). – Kisantu, 1970, leg. H. Vanderyst s.n. (BR A768, as *M. castaneovelutinus*).

Comments – *Marasmius pseudotorquescens* is macroscopically similar to the European *M. torquescens* Quél., and is characterised by having a yellowish brown pileus with dark brown centre, fusoid, (sub)cylindrical, lageniform cheilocystidia (not in the form of broom cells), large, refractive pleurocystidia with a similar shape as the cheilocystidia and by the presence of pileo- and caulosetae.

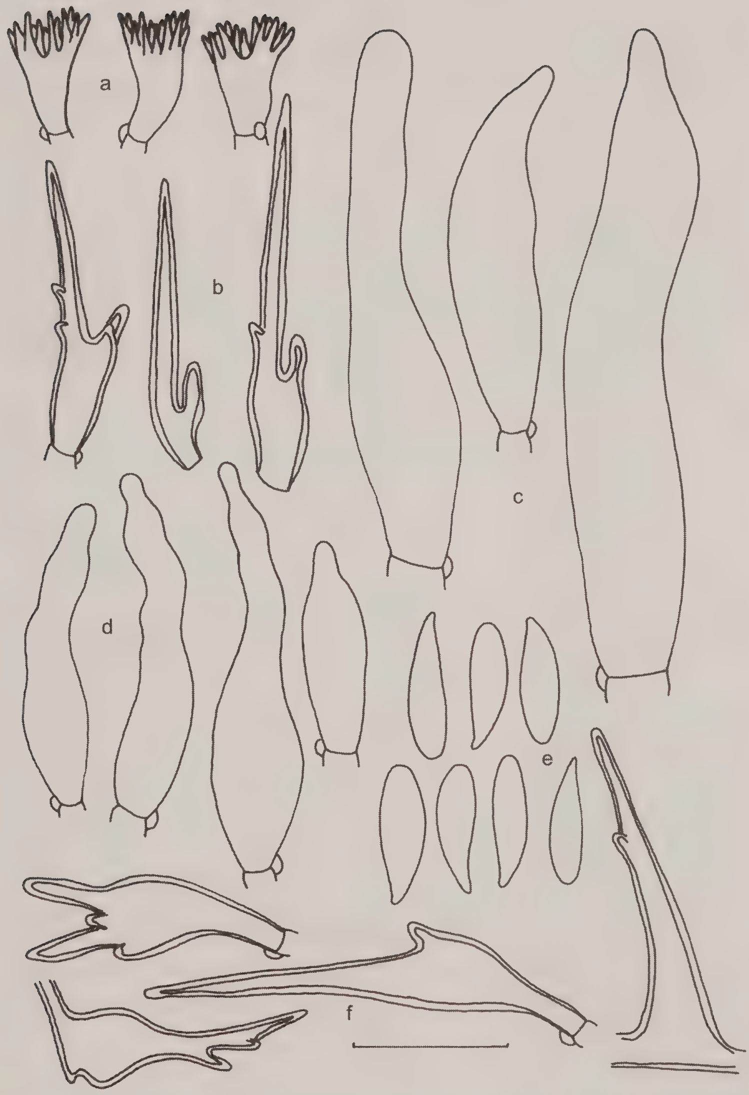

Figure 5. *Marasmius pseudotorquescens* (holotype): a. pileipellis cells, b. pileosetae, c. pleurocystidia, d. cheilocystidia, e. basidiospores, f. caulocystidia. Scale bar = 20 μm.

The presence of fusoid, (sub)cylindrical, lageniform, often rostrate cheilocystidia represents an unique character in sect. *Sicci*. Only *Marasmius mengoënsis* Pegler has similar cheilocystidia. However, it has a small (5–8 mm broad), reddish brown pileus, white lamellae, a smaller stipe (25–35 x 0.3–0.7 mm), distinctly smaller basidiospores (7.5–10 x 4–5 μm), smaller pleurocystidia (25–45 x 8–11 μm), and no pileosetae.

Marasmius rammelooi Antonín sp. nov. Figure 6

Pileo 4 mm lato, convexo, sulcato, pallide aurantiaco-ochraceo, centro obscuriore. Lamellis, L = cca 12, acie irregulariter brunneis. Stipite 3–4 mm longo, cylindraceo, pruinoso, junio albido, dein brunneo. Basidiosporis 13,5–16,9 x 3,8–4,6 μm, clavatis vel clavato-lacrimoideis, hyalinis. Basidiis tetrasporis. Cheilocystidiis 20–37 x 5,0–6,9 μm, cylindraceis vel clavatis, irregularibus vel coralloideis, crassitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 10,8–21 x 7,7–11,5(–17) μm, clavatis, tenuitunicatis vel apicem leviter crassitunicatis. Caulocystidiis e cellulis similibus cellulis hymenodermatis Marasmii sicci, 7,7–14 x 5,4–6,6 μm, tenuitunicatis. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad ramulos putridos.

Holotypus: Mauritius, 10. VI. 1990 leg. J. Rammeloo 9251 (holotype, BR 6902-15).

Pileus 4 mm broad, regularly convex, membranaceous, sulcate, finely tomentose, pale orangish ochraceous (paler than 7.5YR 8/4), slightly darker at centre. **Lamellae** distant, L = c. 12, l = 0, adnate, narrow, with irregularly dark brown edge. **Stipe** 3–4 mm long, cylindrical, finely pruinose, ± white when young, then brown, non-insititious.

Basidiospores 13.5–16.9 x 3.8–4.6 μm, E = 3.2–4.5, Q = 3.8, clavate, clavate-lacrimoid, thin-walled, hyaline, nondextrinoid. **Basidia** 23–30 x 6.9–9.6 μm, 4-spored, clavate. **Basidioles** 15–29 x 2.5–8.0 μm, cylindrical, clavate. **Cheilocystidia** scattered among basidioles, 20–37 x 5.0–6.9 μm, cylindrical to clavate, irregular to subcoralloid, thin-walled, nondextrinoid, hyaline. **Pleurocystidia** absent. **Trama hyphae** cylindrical, thin-walled, hyaline, dextrinoid, up to 8.0 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 10.8–21 x 7.7–11.5(–17) μm, clavate, entirely thin-walled or slightly thick-walled at apex. **Stipitipellis** a cutis consisting of cylindrical, parallel, thick-walled (up to 1.7 μm), nondextrinoid, up to 7.5 μm wide hyphae. **Caulocystidia** 7.7–14 x 5.4–6.6 μm, in the form of clavate to subcylindrical, thin-walled, hyaline broom cells, with subacute to acute, nodulose, thin-walled, up to 7.0 x 1.5 μm large projections, with transitional forms to simple, ± cylindrical, irregular to subcoralloid, thin-walled cells. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on a dead twig.

Distribution – So far known only from the type locality in Mauritius.

REVISED SPECIMENS – MAURITIUS: 10 June 1990 leg. J. Rammeloo 9251 (holotype, BR 6902-15).

Comments – *Marasmius rammelooi* is characterised by having small carpophores with a very pale coloured pileus, distant lamellae with coloured edges, a short stipe, moderately large basidiospores, scattered, irregular to subcoralloid cheilocystidia which are cylindrical to clavate (not in the form of broom cells), a pileipellis consisting of broom cells of the Siccus-type, well-developed caulocystidia in the form of broom cells and lacking pleurocystidia.

A very close species seems to be *M. luteomarginatus* Desjardin, Retnowati & E. Horak. It has slightly larger carpophores (pileus 5–17 mm broad) with an only at margin striate, brightly orange, then orangish white to white pileus, less numerous lamellae (7–9) with brightly yellow edges and an orangish brown stipe at apex (Desjardin & al. 2000). *Marasmius tenuissimus* (Jungh.) Singer has a distinctly larger, 15–40 mm broad, reniform to suborbicular, buff to ochraceous, pale to grey-brown pileus, more distant lamellae (L = 3–6), an absent or only very short eccentric stipe which is concolorous with the pileus, distinctly smaller basidiospores (6.5–10.5 x 4–5 μm), and cheilocystidia in the form of ± poorly developed broom cells (Pegler 1986).

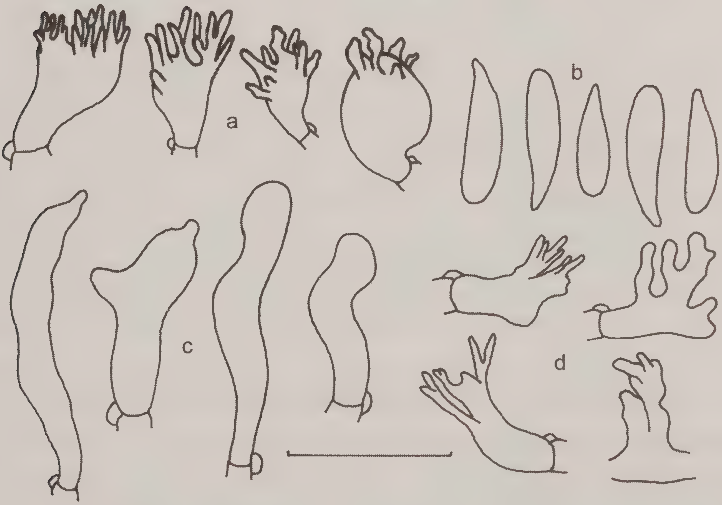

Figure 6. *Marasmius rammelooi* (holotype): a. pileipellis cells, b. basidiospores, c. cheilocystidia, d. caulocystidia. Scale bar = 20 μm.

Marasmius robertsii Antonín sp. nov. **Figure 7**

Pileo usque 5 mm lato, albido. Lamellis sparsis, L = 8–9, non-collariatis. Stipite c. 3–4 mm longo, tenui, curvato, albido. Basidiosporis 11–15(–16) x 3,5–5,5 µm, fusiformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci vel Marasmii rotalis transientibus, 15–25 x 5,5–7,0 µm, clavatis, tenuitunicatis. Pleurocystidiis 26–35 x 9,0–11 µm, ± fusiformibus, clavatis, rostratis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenodermatis Marasmii sicci vel Marasmii rotalis transientibus, 12–25 x 7,0–12 µm, clavatis, subcylindraceis, tenuitunicatis. Caulocystidiis absentibus. Mycelio basale cum cellulis similibus cellulis hymenodermatis Marasmii sicci, dextrinoideis. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad detritum.

HOLOTYPUS: Cameroon, Provincia South West, area protecta Korup, 26. IV. 1996 leg. P.J. Roberts K129 (holotypus in herbario K(M) 42926 asservatur).

Macroscopic description not available, only collector´s notes completed with notes about herbarium specimen. **Pileus** small to minute, up to 5 mm broad, white. **Lamellae** very few, L = 8–9, l = 0–1, sometimes branched, not collariate. **Stipe** c. 3–4 mm long, thin, curved, central, non-insititious, white.

Basidiospores 11–15(–16) x 3.5–5.5 µm, E = 2.6–3.4, Q = 3.0, fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** not found. **Basidioles** 12–23 x up to 10 µm, clavate, fusoid. **Cheilocystidia** in the form of broom cells of the Siccus-type with transient forms to the Rotalis-type, 15–25 x 5.5–7.0 µm, clavate, thin-walled, nondextrinoid. **Pleurocystidia** 26–35 x 9.0–11 µm, ± fusoid, clavate, rostrate, obtuse, thin-walled, nondextrinoid, with slightly refractive contents. **Trama hyphae** cylindrical to subinflated, thin-walled, dextrinoid, smooth or minutely incrusted, up to 14 µm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type with transient forms to the Rotalis-type, 12–25 x 7.0–12 µm, clavate, subcylindrical, thin-walled, with ± fine, digitate, obtuse to subacute, nodulose, thin- to slightly thick-walled, up to 3.0 x 1.0 µm large projections. **Stipitipellis** a cutis consisting of cylindrical, parallel, thick-walled, dextrinoid, up to 5.0 µm wide hyphae. **Caulocystidia** absent; at base with long, narrow (up to 4.0 µm), thick-walled, acute to subacute, dextrinoid hairs. **Basal mycelium** with minute, slightly thick-walled, dextrinoid broom cells with long projections ("*Amyloflagellula*-type"). **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on trapped aerial litter and on a liana.

Distribution – So far known only from Cameroon.

Revised specimens: Cameroon: South West Province, Korup National Park, 26 Apr. 1996 leg. P.J. Roberts K129 (holotype, K(M) 42926). – Ditto, Mundemba, 8 Apr. 1990 leg. R. Watling (E).

Comments – *Marasmius robertsii* is characterised by having very small carpophores with an up to 5 mm broad, white pileus, very few, sometimes branched, not collariate lamellae, a thin, curved, central, non-insititious, white stipe, moderately large, fusoid basidiospores, cheilocystidia in the form of broom cells of the Siccus-type with transient forms to the Rotalis-type, fusoid or clavate, rostrate pleurocystidia, a pileipellis made up of broom cells of the Siccus-type with transient forms to the Rotalis-type with ± fine, digitate and short projections; caulocystidia are lacking and it has minute, slightly thick-walled broom cells with long projections (of the *Amyloflagellula*-type) in the basal mycelium.

This species is apparently similar to *Marasmius pseudoarachnoideus* Dennis (= *Amyloflagellula pseudoarachnoidea* (Dennis) Singer) (Dennis 1951, 1970), which has less numerous lamellae (4–6), larger basidiospores (18–19 x 4 μm) and longer projections of the pileipellis broom cells. *Marasmius robertsii*, having well-developed dextrinoid broom cells with long projections on its basal mycelium, resembles an *Amyloflagellula* species. However, it possesses cheilocystidia in the form of broom cells and flagelliform projections of pileipellis cells are not developed. Therefore, it is described within the genus *Marasmius*.

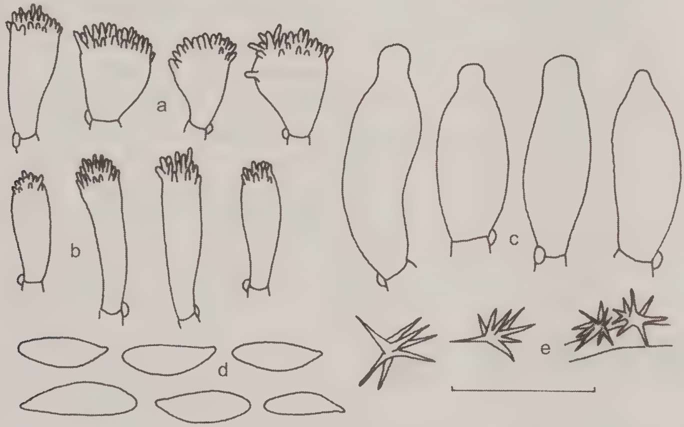

Figure 7. *Marasmius robertsii* (holotype): a. pileipellis cells, b. cheilocystidia, c. pleurocystidia, d. basidiospores, e. Amyloflagellula-type broom cells in basal mycelium. Scale bar = 20 μm.

Marasmius rubrostipitatus Antonín & P. Roberts sp. nov. Figure 8

Pileo 6–15 mm lato, conico vel plano-conico, leviter papillato, subtiliter striato, griseo-brunneo. Lamellis, L = 16–18, angustis, pallide luteis vel luteolo-rubris, acie brunneo maculatis. Stipite 25–40 x usque 0,5 mm, cylindraceo, glabro, apicem pallide luteo, ad basim aurantiaco vel obscure rubro. Basidiosporis 8,2–10,5 x 3,7–4,8 µm, ellipsoideo-fusiformibus vel fusiformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 9,0–15 x 4,0–8,0 µm, cylindraceis vel subclavatis. Pleurocystidiis 26–45 x 7,7–11 µm, fusiformibus, subcylindraceis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 9,0–16 x 6,0–8,5 µm, clavatis, pyriformibus vel subcylindraceis, tenuitunicatis, ad basim tenuitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad folia putrida.

Holotypus: Cameroon, Provincia South West, area protecta Korup, 4. V. 1996 leg. P. J. Roberts K493 (holotypus in herbario K(M) 39594 asservatur).

Pileus c. 6–15 mm broad, conical to plano-conical, sometimes slightly papillate, slightly striate, matt, grey-brown. **Lamellae** moderately close, L = 16–18, L = 2–3, ± narrow, cream to pale buff, with brown spotted edge. **Stipe** 25–40 x up to 0.5 mm, cylindrical, smooth, glabrous, lustrous, cream at apex, orange to dark red towards base.

Basidiospores 8.2–10.5 x 3.7–4.8 μm, E = 1.9–2.6, Q = 2.2, ellipsoid-fusoid or fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** 24 x 7.5 μm (only one found), 4-spored, clavate. **Basidioles** 14–26 x 4.5–7.5 μm, fusoid, clavate, cylindrical. **Cheilocystidia** in the form of broom cells of the Siccus-type, 9.0–15 x 4.0–8.0 μm, cylindrical to subclavate, thin-walled, nondextrinoid, with thin-walled, nodulose, obtuse to subacute, up to 7.5 x 1.2 μm projections. **Pleurocystidia** 26–45 x 7.7–11 μm, fusoid, subcylindrical, often with an obtuse rostrum, often originating in the subhymenium, thin-walled, nondextrinoid, with refractive contents. **Trama hyphae** cylindrical to subinflated, thin-walled, hyaline, dextrinoid, up to 12 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 9.0–16 x 6.0–8.5 μm, clavate, pyriform or subcylindrical, thick-walled with ± thin-walled base or entirely slightly thick-walled, with 10–25 nodulose, obtuse to subacute, slightly thick-walled, up to 10 x 1.2 μm projections; thick-walled parts ochraceous brown in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 6.0 μm wide hyphae, with ochraceous (reddish) brown walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on fallen leaves.

Distribution – So far known only from the type locality in Cameroon.

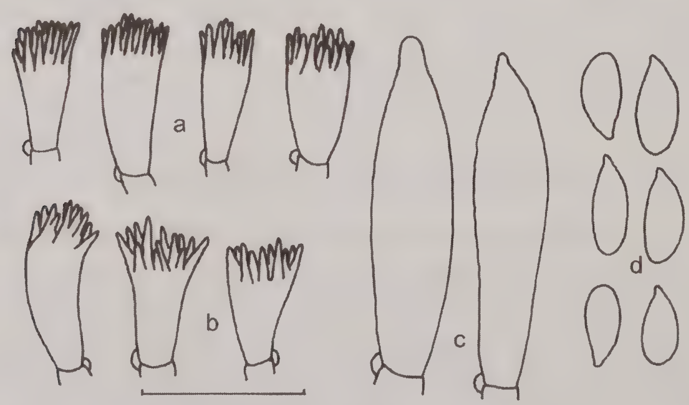

Figure 8. *Marasmius rubrostipitatus* (holotype): a. pileipellis cells, b. cheilocystidia, c. pleurocystidia, d. basidiospores. Scale bar = 20 μm.

Revised specimens: Cameroon: South West Province, Korup National Park, trail from Rengo Camp to Ekunde-Kunde, 4 May 1996 leg. P. J. Roberts K493 (holotype, K(M) 39594, as *M. spegazzinii*).

Comments – *Marasmius rubrostipitatus* is characterised by having a conical to plano-conical, grey-brown pileus, close lamellae, an orange to dark red stipe at base, rather small basidiospores, rather short pleurocystidia, rather small pileipellis broom cells and cheilocystidia; caulocystidia are lacking.

A very close species seems to be *M. spegazzinii* Sacc. & P. Syd., which especially differs in having an orange-ferrugineous, at margin paler pileus, an umbrinous to black stipe, narrower basidiospores (8.0–10 x (2.5–)3.0–3.5 (–4.0) μm), larger cheilocystidia (15–22 x 7.5–9.0 μm), broader pleuro-cystidia (35–55 x 10–21 μm) and a pileipellis of two types of broom cells.

Among other small-spored *Marasmius* species, *Marasmius nocturnus* Har. Takahashi has a light yellow, reddish yellow, light orange to orange, later brown pileus, very narrow pleurocystidia (25–45 x 4–6 μm) and large pileipellis broom cells (20–28.5 x 5–12 μm) (Takahashi 2000); *M. hylaeae* Singer has a rusty spadiceous pileus with lighter brown margin and smaller pleurocystidia (18–35 x 5.5–7 μm); *M. pseudocorrugatus* Singer has a larger (20–62 mm), dull cinnamomeous, sometimes olivaceous tinged pileus; *M. aztecus* Singer has a brightly ochraceous brown to rusty brown or orange pileus, a longer stipe (40–106 x (0.8–)1–2.5 mm) and larger basidiospores ((7.7–)8–13 x (2.5–)3–4 μm) (Singer 1976); moreover, none of them has a similar stipe colour.

Marasmius striaepileus Antonín sp. nov. Figure 9

Pileo 15–30 mm lato, campanulato vel applanato, aurantiaco-brunneo, centro brunneo, pallide striato. Lamellis, L = 17–20, adnatis, albidis. Stipite 40–60 x 1 mm, cylindraceo, glabro, junio pallide, dein obscure brunneo. Basidiosporis 15,5–18,5(–19,2) x 3,5–5,0 μm, clavatis, anguste lacrimoideis vel fusiformibus, hyalinis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, 10,8–16,2 x 5,4–8,5 μm, clavatis vel subcylindraceis, tenuitunicatis. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 10–15,5 x 6,6–9,2 μm, clavatis vel cylindraceis, tenuitunicatis, apicem subtiliter crassitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. In ligno putrido et ad corticem arboris.

Holotypus: Burundi, Provincia Bururi, Kigwena, silva Kigwena, 22. II. 1979 leg. J. Rammeloo 6724 (holotypus in herbario BR 11953-22 asservatur).

Pileus 15–30 mm broad, campanulate to applanate, membranaceous, apparently glabrous, slightly mealy under lens, sulcate ± up to centre, orange-brown (6C8), darker, brown (6D5) at centre, with paler stripes. **Lamellae** distant, L = 17–20, l = 0–1(–2), adnate, moderately large (2.5–3 mm), thin, white, then slightly darker, with concolorous, finely pubescent edge. **Stipe** 40–60 x 1 mm, cylindrical, smooth, glabrous, hollow, pale when young, then dark brown. **Smell** indistinct. **Taste** fungoid.

Basidiospores 15.5–18.5(–19.2) x 3.5–5.0 μm, E = 3.4–4.6, Q = 4.0, clavate to narrowly lacrimoid or fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** not found. **Basidioles** 11.5–26 x 4.5–7.7 μm, cylindrical, clavate, fusoid.

Cheilocystidia in the form of broom cells of the Siccus-type, 10.8–16.2 x 5.4–8.5 μm, clavate to subcylindrical, entirely thin-, rarely slightly thick-walled below, slightly to distinctly thick-walled above, with nodulose, digitate, up to 12 μm long projections. **Pleurocystidia** absent. **Trama hyphae** cylindrical to subinflated, thin- to slightly thick-walled, dextrinoid, up to 12 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 10–15.5 x 6.6–9.2 μm, clavate or cylindrical, thin-walled with slightly thick-walled apex, with 3–15 conical to subulate, mostly subacute, thick-walled, up to 20 x 2.1 μm projections; thick-walled parts ochraceous in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 6.0 μm wide hyphae with ochraceous yellowish walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on dead and decaying wood as well as on bark of a living tree.

Distribution – Known only from the type locality in Burundi.

REVISED SPECIMENS: BURUNDI: Bururi Province, Kigwena, Kigwena Forest, 22 Feb. 1979 leg. J. Rammeloo 6724 (holotype, BR 11953-22).

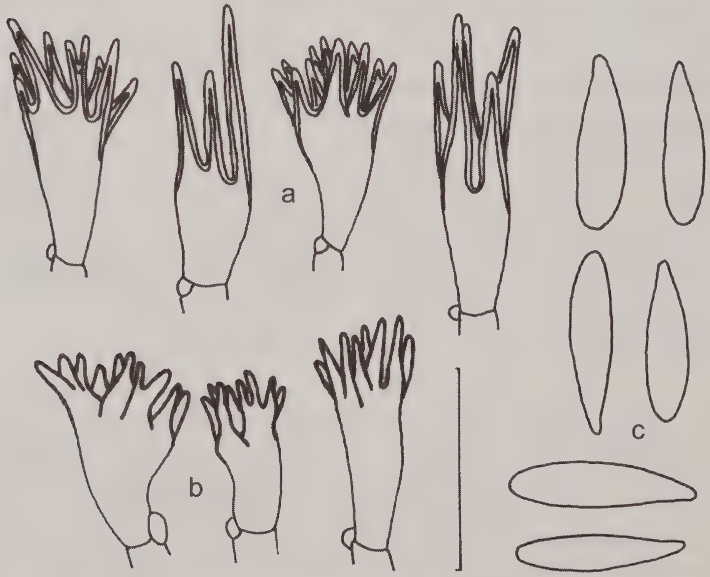

Figure 9. *Marasmius striaepileus* (holotype): a. pileipellis cells, b. cheilocystidia, c. basidiospores. Scale bar = 20 μm.

Comments – *Marasmius striaepileus* is characterised by having a rather large, striped, orange-brown to brown pileus, distant lamellae, a dark brown stipe, moderately large basidiospores and large projections of cheilocystidia and pileipellis broom cells. It lacks pleuro- and caulocystidia.

Marasmius corrugatus (Pat.) Sacc. & P. Syd. has an only at margin striate, otherwise rugulose pileus, a shorter stipe (20–35 x 1–2.5 mm) and smaller basidiospores (9–13 x 2.3–4 μm) (Pegler 1983); *M. trinitatis* Dennis differs especially in having only 9–11.5 x 3.5–4 μm (Singer 1976: 8.3–12.5 x 2.7–4 μm) basidiospores (Dennis 1951, Desjardin & Horak 1997); *M. fulviceps* Berk. has a smaller (10–15 mm), non-striate pileus, smaller basidiospores (10–12.5 x 4–5 μm) and smaller cheilocystidia (7–9 x 3–4 μm) and pileipellis broom cells (7–10 x 4–7 μm) (Pegler 1986).

Marasmius tanougouensis Antonín sp. nov. Figure 10

Pileo 9–20 mm lato, late conico vel convexo, junio papillato, dein umbilicato cum vel sine papilla, striato-sulcato, centro ruguloso, obscure brunneo-aurantiaco, dein pallide griseo- vel aurantiaco-brunneo, marginem aurantiaco-ochraceo. Lamellis, L = (8–)10–16, adnatis, pallide ochraceo-luteis. Stipite 11–33 x 0,2–0,8 mm, cylindraceo, glabro, junio apicem subtiliter pruinoso, albido, dein pallide ochraceo vel luteo, ad basim aurantiaco-brunneo vel obscure brunneo. Basidiosporis (11,5–) 12,5–15,5 x 3,5–5,0(–5,5) μm, clavatis vel fusiformibus, hyalinis. Cheilocystidiis e cellulis similibus cellulis typo Marasmii sicci, (10–)12–20(–24) x 4,5–10 μm, anguste clavatis vel subcylindraceis, tenuiparietalibus. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 11–20(–25) x 6,0–11 μm, clavatis vel cylindraceis, tenuitunicatis et apicem subtiliter crassitunicatis vel crassitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite et trama dextrinoideis. Ad lignam et ramulos putridos et ad corticem arboris.

Holotypus: Benin, Provincia Atacora, Tanougou, cataracta Tanougou, 9. IX. 1997 leg. V. Antonín B97.190 (holotypus in herbario BR101225-54 asservatur).

Carpophores single. **Pileus** 9–20 mm broad, broadly conical to convex with a small conical central papilla when young, then ± conical to almost applanate with central depression with small papilla or without it, with involute, then straight to slightly uplifted, crenulate and slightly translucently striate margin, striate-sulcate, finely tomentose, slightly rugulose at centre, brownish orange (6B5–6, 6B–C8, 7C7–8) at centre, and slightly paler (5–6A5) towards margin when young, pallescent to pale greyish to orange brown (6B5–7, 6C6) at centre and orange-ochraceous (5–6A5) towards margin when old (rarely almost whitish at margin when old). **Lamellae** distant, L = (8–)10–16, l = 0–1, broadly adnate to an adpressed pseudo-collarium, narrow (up to 2 mm), slightly intervenose at base when old, pale ochraceous-cream (3–5A2–3) when young, slightly paler (3–4A2) when old, with concolorous, finely pubescent edge. **Stipe** 11–33 x 0.2–0.8 mm, cylindrical, slightly broadened at apex, slightly broadened to subbulbillose, mostly slightly curved, lustrous, smooth, glabrous, very slightly pruinose at apex when young, translucently whitish when very young, then pale ochraceous to cream-ochraceous (3–5A2–3, ± concolorous with lamellae) at apex, through an orange-brown zone up to dark brown (7–8E–F7–8) towards base; with well-developed dirty yellowish pad of basal mycelium on substrate around stipe base.

Basidiospores (11.5–)12.5–15.5 x 3.5–5.0(–5.5) μm, E = 2.6–4.0, Q = 2.9–3.4, clavate to fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** 27–32 x 6.5–9.0 μm, 4-spored, clavate. **Basidioles** 13–38(–43) x 3.7–10 μm, cylindrical, clavate, fusoid. **Cheilocystidia** in the form of broom cells of the Siccus-type, (10–)12–20(–24) x 4.5–10 μm, (narrowly) clavate to subcylindrical, thin-walled, nondextrinoid, with nodulose, thin- to slightly thick-walled, short, up to 3.0 x 1.0 μm projections; mixed with rare smooth elements. **Pleurocystidia** absent. **Trama hyphae** cylindrical to subinflated, thin- to sligthly thick-walled, dextrinoid, up to 20 μm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 11–20(–25) x 6.0–11 μm, clavate or cylindrical, thin-walled with slightly thick-walled apex, mixed with entirely thick-walled ones, with 10–25(–35) digitate, nodulose, obtuse to subacute, slightly thick-walled, up to 4.0 x 1.0(–1.5) μm projections; some cells transient to subcoralloid broom cells; thick-walled parts ochraceous in KOH. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 5.0 μm wide hyphae with hyaline (above) to ochraceous (below) walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on dead and decaying wood and twigs as well as on bark of a living tree.

Distribution – Known only from several localities in Benin and the Democratic Republic of Congo.

REVISED SPECIMENS – BENIN: Atacora Province, Tanougou, Choutes de Tanougou, 9 Sept. 1997 leg. V. Antonín B97.190 (holotype, BR101225-54). – Ditto, 8 Sept. 1997 leg. V. Antonín B97.176 (BR 101214-43). – Ditto, 26 Aug. 1997 leg. V. Antonín B97.108 (BR). – Atacora Province, Kounagnigou, 3 Sept. 1997 leg. V. Antonín B97.145 (BR 101188-17). – Atacora Province, Kota, 29 Aug. 1997 leg. V. Antonín B97.122 (BR 101166-92). – Borgou province, Wari Maro, 21 Aug. 1997 leg. V. Antonín B 97.74 (BR 101122-48). – **DEMOCRATIC REPUBLIC OF CONGO:** Katanga Province, Plateau de Biano, Mengé, 4 Apr. 1986 leg. J. Schreurs 1594 (BR 8343-01).

Comments – *Marasmius tanougouensis* is characterised by having a rather small, brownish orange to pale orange-brown pileus, distant lamellae, a filiform, orange-brown to dark brown stipe, moderately large basidiospores and very short projections of cheilocystidia and pileipellis broom cells. It lacks pleuro- and caulocystidia.

Collection J. Schreurs 1594 differs only in having longer projections of the cheilocystidia (1.5–5.5 μm long) and pileipellis broom cells (3.5–7.5 μm long); in other features, it agrees with the other mentioned collections.

Among species of series *Leonini* without caulocystidia and with cheilo-cystidia in the form of broom cells, *Marasmius subconiatus* Petch has a paler, light orange, 4–7 mm broad pileus, lamellae with an orange edge, a smaller (7–11 x 0.05–0.1 mm), dark brown to black stipe and smaller basidiospores (6.5 x

2.5 μm) (Desjardin & al. 2000); *M. berteroi* (Lév.) Murrill has an only 2–11 mm broad pileus (8–15 mm broad according to Singer 1976), and an entirely brown to dark brown stipe (Desjardin & al. 2000); *M. corrugatus* (Pat.) Sacc. & P. Syd. has a 10–47 mm broad pileus, a more robust, 20–33 x 1–2.5 mm stipe, smaller, 7.5–11 x 3–4.5 μm basidiospores and smaller, up to 20 μm long basidia (Pegler 1983, Singer 1976). *Marasmius bambusiniformis* Singer has an only 3–12 mm broad, orange buff to pale reddish brown pileus, lamellae with an orange-brown edge, and larger basidiospores (15–18 x 3–4.5(–5) μm) (Desjardin & Horak 1997, Singer 1976); *M. onoticus* Singer has an only 5–6 mm broad pileus, longer, 13.8–18 x 3.5–4.8 μm basidiospores and longer (5.5–8.5 x 1.2–1.8 μm) projections of pileipellis broom cells (Singer 1976).

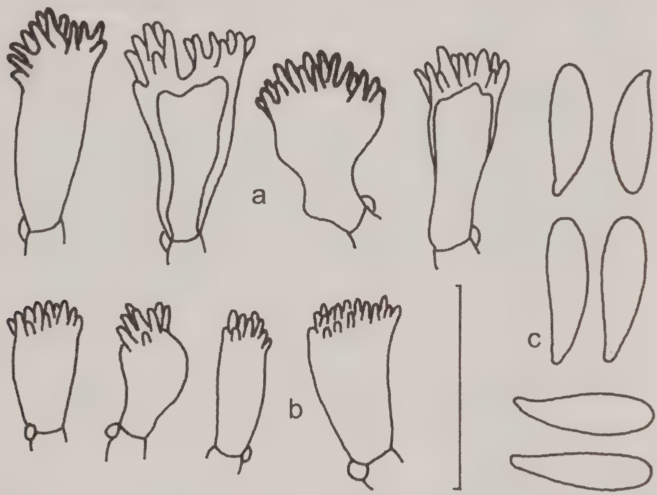

Figure 10. *Marasmius tanougouensis* (holotype): a. pileipellis cells, b. cheilocystidia, c. basidiospores. Scale bar = 20 μm.

Marasmius xestocephaloides Antonín sp. nov. Figure 11

Pileo 10–30 mm lato, convexo, subumbonato, non-striato, ochraceo vel pallide brunneo, centro obscuriore. Lamellis confertis, liberis vel adnexis, angustis, pallide alutaceis vel ochraceis. Stipite 15–40 x 1–1,5 mm, cylindraceo, saepe curvato, subtiliter pruinoso, apicem albido, ad basim castaneo-brunneo. Basidiosporis 8,0–9,5 x 3,7–4,2 μm, ellipsoideis-fusiformibus, fusiformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis 18–35 x 5,0–8,5 μm, lageniformibus, fusiformibus, plerumque rostratis, irregularibus, tenuitunicatis. Pileipellis hymeniformis, 1) e cellulis similibus cellulis hymenodermatis Marasmii sicci vel Marasmii rotalis transitoris vel sublaevibus, 12–22 x 7,0–16 μm, clavatis, pyriformibus, cylindraceis vel vesiculosis, tenui- vel subtiliter crassitunicatis; 2) e cellulis similibus cellulis hymenodermatis Marasmii sicci vel setas transitoriis, usque 65 x 8,0 μm. Caulocystidiis 25–40 x 7,0–11 μm, cylindraceis, subfusiformibus, subclavatis, ± crassitunicatis. Hyphis fibulatis, in stipite et trama dextrinoideis. In ligno putrido et ad detritum.

Holotypus: Kenya, Provincia Central, Districtus Nairobi, Thika, cataracta Thika, 16. III. 1968 leg. D.N. Pegler 94 (holotypus in herbario K(M) 116841 asservatur).

Misapplied name: *Marasmius xestocephalus* Singer s. Pegler (1977).

Pileus 10–30 mm broad, convex, subumbonate, smooth, glabrous, ochraceous to light brown, darker at centre. **Lamellae** very crowded, l = 3, free to adnexed, narrow (up to 1 mm), pale alutaceous to ochraceous. **Stipe** 15–40 x 1–1.5 mm, cylindrical, often curved, hollow, finely pruinose, whitish above, chestnut brown below; with whitish, strigose mycelium at base. **Context** thin, whitish. (According to Pegler 1977).

Basidiospores 8.0–9.5 x 3.7–4.2 µm, E = 2.0–2.6, Q = 2.2, ellipsoid-fusoid, fusoid, thin-walled, smooth, hyaline, nondextrinoid. **Basidia** 20–24 x 5.0–7.5 µm, 4-spored, clavate. **Basidioles** 15–21 x 4.0–7.0 µm, clavate, cylindrical, fusoid. **Cheilocystidia** 18–35 x 5.0–8.5 µm, lageniform, (sub) fusoid, mostly rostrate, irregular, thin-walled, hyaline, nondextrinoid. **Pleurocystidia** absent. **Trama hyphae** cylindrical to subinflated, thin-walled, hyaline, up to 15 µm wide, mixed with slightly thick-walled, dextrinoid, up to 8.0 µm wide ones. **Pileipellis** a hymeniderm made up of (1) broom cells of the Siccus-type, sometimes transient to the Rotalis-type, sometimes (almost) smooth, 12–22 x 7.0–16 µm, clavate, pyriform, cylindrical or vesiculose, thin- to slightly thick-walled, with up to 10 x 1.5 µm, ± slightly thick-walled, obtuse and smooth projections, and (2) up to 65 x 8.0 µm distinctly thick-walled broom cells transient to setoid cells (however, true setae absent!); subpileipellis made up of ± globose cells. **Stipitipellis** a cutis consisting of cylindrical, parallel, slightly thick-walled, dextrinoid, up to 8.0 µm wide hyphae, with subhyaline to pale yellowish walls in KOH. **Caulocystidia** numerous, 25–40 x 7.0–11 µm, cylindrical, subfusoid, subclavate, ± thick-walled, with subhyaline to pale yellowish walls in KOH. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing in ± dense groups on dead wood and forest debris (e.g. *Sysygium* sp.).

Distribution – So far known only from Kenya, Uganda and probably from Zambia.

REVISED SPECIMENS – KENYA: Central Province, Nairobi District, Thika, Thika Falls, 16 March 1968 leg. D.N. Pegler 94 (holotype, K(M) 116841, as *M. xestocephalus*). – **UGANDA:** Buganda Province, Mengo District, Mawakota County, Mpanga Reserve Forest, 8 June 1968 leg. D.N. Pegler U1330 (K, as *M. xestocephalus*). – **ZAMBIA:** ? Chowo Forest, 12 Dec. 1981 leg. J. Rammeloo 7843 (BR 12027-96).

Comments – *Marasmius xestocephaloides* is characterised by having an ochraceous to light brown pileus, very crowded lamellae, a chestnut brown stipe base, small basidiospores, short basidia and basidioles, cheilocystidia never in the form of broom cells but lageniform, (sub)fusoid and mostly rostrate and irregular, a pileipellis made up of both ± thin-walled broom cells and (almost) smooth cells, mixed with distinctly thick-walled broom cells transient to setoid cells, and in having cylindrical, subfusoid or subclavate, ± thick-walled caulocystidia. Pleurocystidia as well as true setae are not developed.

Collection J. Rammeloo 7843 from Zambia is very similar, both macroscopically (± same colour of carpophores, very close narrow lamellae and growth in dense groups) and microscopically (pileipellis a mixture of broom- and smooth cells, similar caulocystidia). However, its cheilocystidia are in the form of broom cells mixed with smooth, regular, lobate to subcoralloid cells. Therefore, it is included with a question-mark here.

Marasmius xestocephalus Singer represents a very close species. It differs in having smaller carpophores, larger basidiospores (11.5–14 x 4.5–5.5 μm), longer basidia and basidioles (27–30 x 8.0–10 μm), cheilocystidia in the form of broom cells, and different pileipellis broom cells. *Marasmius subarborescens* Singer has a white pileus, different cheilocystidia, and even smaller basidiospores (6.0–8.0 x 3.0–3.2 μm).

The absence of cheilocystidia in the form of broom cells represents a unique character in this series. Only *Marasmius heterocheilus* Singer is described as having mostly clavate and simple, rarely cylindrical or clavate cheilocystidia with one to four apical projections, which are often irregularly contorted. However, it differs in having a cinnamomeous coloured, up to 50 mm broad pileus, a longer and more robust stipe (up to 80 x 4 mm), smaller basidiospores (6–6.3 x 3.5–4 μm), and differently shaped caulocystidia with the same form as the cheilocystidia (Singer 1976).

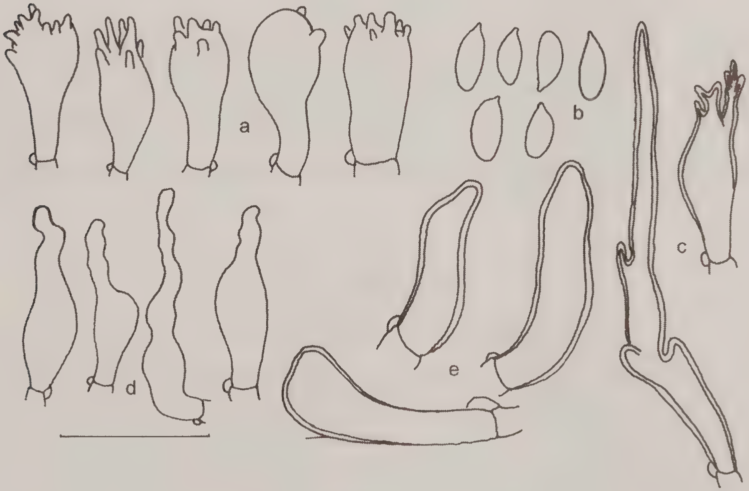

Figure 11. *Marasmius xestocephaloides* (holotype): a. pileipellis cells, b. basidiospores, c. pileosetae, d. cheilocystidia, e. caulocystidia. Scale bar = 20 μm.

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References

Antonín V. 2003a. New species of Marasmius (Basidiomycetes, *Tricholomataceae*) from tropical Africa – I. Sect. *Epiphylli, Fusicystiddes, Globulares, Hygrometrici* and *Neosessiles*. Mycotaxon 85: 109-130.

Antonín V. 2003b. New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa - II. *Gloiocephala, Marasmius, Setulipes* and two new combinations. Mycotaxon 88: 53-78.

Dennis RWG. 1951. Some agaricaceae of Trinidad and Venezuela. Leucosporae. Part 1. Trans. Brit. Mycol. Soc. 34: 411-482.

Dennis RWG. 1970. Fungus flora of Venezuela and adjacent countries. Kew Bull. Addit. Ser. 3: 1-531.

Desjardin DE., Horak E. 1997. *Marasmius* and *Gloiocephala* in the South Pacific Region: Papua New Guinea, New Caledonia, and New Zealand taxa. Part 1: Papua New Guinea and New Caledonia taxa. Part 2: New Zealand taxa. In: Petrini O., Petrini LE., Horak E. (eds.), Taxonomic monographs of Agaricales II, Bibl. Mycol. 168: 1-152.

Desjardin DE., Retnowati A., Horak E. 2000. Agaricales of Indonesia. 2. A preliminary monograph of *Marasmius* from Java and Bali. Sydowia 52(2): 92-194.

Hennings P. 1905. Fungi camerunenses. IV. Bot. Jarhb. Syst. 38: 119-129.

Pegler DN. 1977. A preliminary agaric flora of East Africa. Kew Bull. Addit. Ser. 6: 1-615.

Pegler DN. 1983. Agaric flora of the Lesser Antilles. Kew. Bull. Addit. Ser. 9: 1-668.

Pegler DN. 1986. Agaric flora of Sri Lanka. Kew Bull. Addit. Ser. 12: 1-519.

Singer R. 1976. *Marasmiae* (Basidiomycetes, *Tricholomataceae*). Fl. Neotrop. Monogr. 17: 1-347.

Takahashi H. 2000. Three new species of *Marasmius* section *Sicci* from eastern Honshu, Japan. Mycoscience 41: 313-321.

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New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa IV. Four new taxa of the genus *Marasmius* and one new combination

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Abstract—Four new African tropical taxa of the genus *Marasmius*, *M. aurantiostipitatus*, *M. curreyi* var. *distantifolius*, *M. rotalis* var. *latisporus* (sect. *Marasmius*) and *M. subalbidulus* (sect. *Hygrometrici*) are described and one new combination, *Setulipes congolensis*, is proposed.

Key words—*Agaricales,* new taxa, taxonomy, nomenclature

Introduction

This paper represents the fourth part of a series of descriptions of new taxa of the genera *Gloiocephala, Marasmius* and *Setulipes* from tropical Africa. The complete study of these genera will be published in a series of monographs under the name „Flore illustrée des champignons d´Afrique centrale“ edited by the National Botanical Garden in Meise (Belgium) in 2004. For material and methods see Antonín (2003a).

Species descriptions

Marasmius aurantiostipitatus Antonín & P. Roberts spec. nov. Figure 1

Pileo usque 10 mm lato, campanulato, umbilicato, brunneo roseo vel roseo rubro. Lamellis collariatis, L = 10–12, albidis. Stipite usque 45 x 0,5 mm, filiforme, insititio, glabro, aurantiaco vel obscuriore aurantiaco. Basidiosporis 13,5–18 x 4,5–7,5 µm, lacrimiformibus vel fusiformibus, hyalinis. Basidiis tetrasporis. Cheilocystidiis e cellulis typo Marasmii sicci similibus, 7,5-21 x 5,5-11 µm, clavatis, subcylindraceis. Pleurocystidiis absentibus. Pileipellis hymeniformis, e cellulis similibus cellulis hymenidermatis Marasmii sicci, 10–20 x 4,5–11 µm, clavatis, sub-cylindraceis vel pyriformibus, (subtiliter) crassitunicatis. Caulocystidiis absentibus. Hyphis fibulatis, in stipite dextrinoideis. Ad folia and ramulos putridos.

Holotypus: Cameroon, South West Province, Korup National Park, trail from Rengo Camp to Erat, 2 May 1996, leg. P.J. Roberts K356 (holotypus in herbario K(M) 39176 asservatur).

Pileus up to 10 mm broad, campanulate, umbilicate, with a very small central papilla or without it, sulcate, smooth, brownish pink to dark pinkish red (maroon). **Lamellae** distant, L = 10–12, l = 0(–1), rather indistinctly collariate, broad, white, with concolorous edge. **Stipe** up to 45 x 0.5 mm, filiform, smooth, glabrous, lustrous, orange to deep orange; sterile stipes and rhizomorphs present.

Basidiospores 13.5–18 x 4.5–7.5 µm, E = 2.4–3.5, Q = 3.0, lacrimoid to fusoid, thin-walled, hyaline, nondextrinoid, smooth. **Basidia** 30–33 x 7.5–10 µm, 4-spored, clavate. **Basidioles** 18–38 x 4.0–8.0 µm, clavate, sub-cylindrical, fusoid. **Cheilocystidia** in the form of broom cells of the Siccus-type, 7.5–21 x 5.5–11 µm, clavate, subcylindrical, thin-walled, with thin- to slightly thick-walled, obtuse, up to 7.0 x 1.5 µm large projections. **Pleuro-cystidia** absent. **Tramal hyphae** cylindrical or subinflated, smooth, hyaline, dextrinoid, up to 15 µm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, 10–20 x 4.5–11 µm, clavate, pyriform or subcylindrical, slightly to distinctly thick-walled (up to 1.5 µm), with conical or cylindrical, thick-walled, obtuse, up to 8.0 x 1.5 µm large projections; mixed with thick-walled broom cells or coralloid cells; thick-walled parts with pale ochraceous-brown walls in KOH. **Stipitipellis** a cutis made up of cylindrical, parallel, slightly thick-walled, smooth, up to 5.0 µm wide hyphae with dark brown walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing gregariously on dead leaves and twigs.

Distribution – So far known only from Cameroon.

REVISED SPECIMENS – CAMEROON: South West Province, Korup National Park, trail from Rengo Camp to Erat, 2 May 1996 leg. P.J. Roberts K356 (holotype, K(M) 39176). – Ditto, trail from Rengo Camp to Ekunde – Kunde, 4 May 1996 leg. P.J. Roberts K494 (K(M) 39177).

Comments – *Marasmius aurantiostipitatus* is characterised by having a brownish pink to dark pinkish red pileus, distant, rather indistinctly collariate lamellae with concolorous edge, an orange to deep orange stipe, rather large basidiospores, cheilocystidia with obtuse projections, and a pileipellis of slightly to distinctly thick-walled broom cells with obtuse projections, mixed with thick-walled broom cells or coralloid cells. It belongs to sect. *Marasmius*.

Among species growing in tropical Africa, *Marasmius guyanensis* Mont. has a yellow orange, orange, brownish red or ferrugineous pileus, less numerous lamellae (L=6–10), a black stipe and smaller basidiospores ((9.0–) 10–13.5(–14) x (3.0–)3.5–4.5(–5.0) µm); *M. lovedalensis* Antonín & Verbeken has a smaller, 2–5 mm broad, orange pileus, black coloured stipe and smaller basidiospores, 11–13(–14.5) x 4.5–6.0 μm large (Antonín 2003). *Marasmius marthae* Singer, with a similarly coloured pileus, has more numerous lamellae (L = 16–17) with a deep purple edge and narrower basidiospores ((8.3–)14.5–16 x 4(–4.3) μm); *M. xerampelinus* Singer has a purple red or purple pileus, a shorter (10–19 x 0.3–0.4 mm) black stipe and smaller, (6–)8.5–11 x (4–)5.5–7.5 μm large basidiospores (Singer 1976).

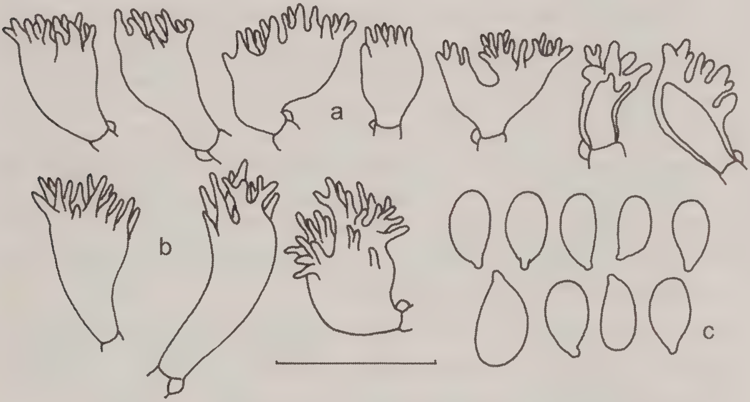

Figure 1. *Marasmius aurantiostipitatus* (holotype): a. pileipellis cells, b. cheilocystidia, c. basidiospores. Scale bar = 20 μm.

Marasmius curreyi Berk. & Broome var. *distantifolius* Antonín var. nov.

Figure 2

A varietate typica lamellis distantis et acie ferrugineis differt.

Holotypus: Benin, Oueme Province, Agongo, 17 VIII. 1997 leg. V. Antonín B 97.40 (BR 101094-20).

Pileus 1.5–8 mm broad, hemispherical to convex with central umbilicus with a (distinctly projecting) papilla when young, then campanulate-convex to broadly convex, rarely almost applanate with papilla when old, sulcate, crenulate at margin, finely pubescent, slightly cracking around umbilicus when old, cinnamomeous brown to reddish (up to 8C7–8) when young, pallescent with age up to pinkish ochraceous (6A4–7A4), sometimes washed-up up to whitish at margin when old, always dark brown at centre. **Lamellae** distant, L = (6–)7–9, l = 0(–1), broad, sometimes almost ventricose when old, slightly intervenose at base when old, collariate, collarium often funnel-shaped when old, pale cream when young (paler than 5A2), sometimes with an ochraceous tinge when old, with (irregularly) red-brown, finely pubescent edge. **Stipe** 4–12 x 0.1–0.2 mm, filiform, lustrous, insititious, smooth and glabrous, concolorous with lamellae at apex, through brown to black-brown towards base.

Basidiospores (8.0–)9.0–10.5(–12) x (4.5–)5.0–6.0 µm, E = 1.6–2.3, Q = 1.8, (broadly) ellipsoid, ellipsoid-fusoid, thin-walled, smooth, hyaline, indextrinoid. **Basidia** 24–28 x 8.0–10 µm, 4-spored, clavate. **Basidioles** 18–30 x 4.0–11 µm, cylindrical, clavate, fusoid. **Cheilocystidia** shaped as broom cells of the Siccus-type, 10–23 x 6.5–12 µm, clavate, subcylindrical, thin-walled with slightly thick-walled, nodulose, obtuse, up to 10 x 2.0 µm projections; projections with slightly greyish yellowish walls in KOH. **Pleurocystidia** absent. **Trama hyphae** cylindrical to subinflated, branched, thin-walled, smooth to minutely incrusted, nondextrinoid, up to 12 µm wide. **Pileipellis** a hymeniderm made up of broom cells of the Siccus-type, (5.0–)12–18 x 5.0–11(–13) µm, (broadly) clavate, subcylindrical, ± thin-walled, with slightly thick-walled, nodulose, digitate, obtuse projections, mixed with entirely or at least in upper part thick-walled, ± coralloid cells or broom cells; thick-walled parts greyish ochraceous in KOH. **Pileocystidia** absent. **Stipitipellis** a cutis made up of cylindrical, parallel, slightly thick-walled, smooth, dextrinoid, up to 6.0 µm wide hyphae with brown walls in KOH. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – Saprophytic, growing on grass remnants in open grassy place.

Distribution – Known only from Benin.

REVISED SPECIMENS – BENIN: Oueme Province, Agongo, 17 Aug. 1997 leg. V. Antonín B 97.40 (holotype, BR 101094-20).

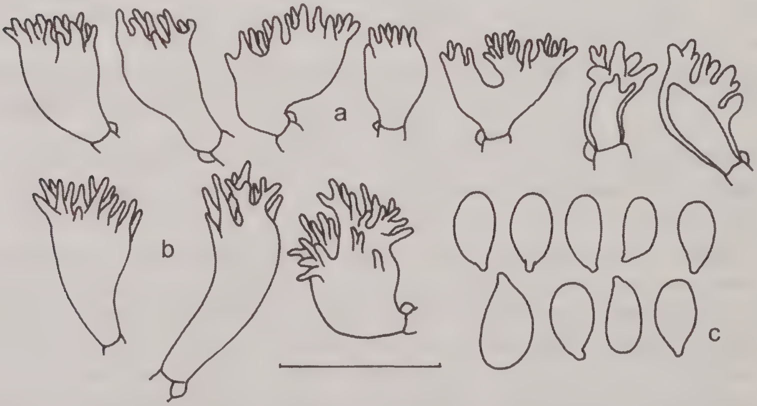

Figure 2. *Marasmius curreyi* var. *distantifolius* (holotype): a. pileipellis cells, b. cheilocystidia, c. basidiospores. Scale bar = 20 µm.

Comments – *Marasmius curreyi* var. *distantifolius* is especially characterised by coloured lamellar edge and distant lamellae. The closest var. *culmisedus* Singer differs by slightly longer and narrower basidiospores ((8–)9–12.3 x (4–)4.2-5.3(–7) µm) and closer lamellae (L = 9–18) (Singer 1976, as *M.*

graminum var. *culmisedus*). Other varieties differ by white coloured lamellar edge, differently numerous lamellae and/or different size of basidiospores (Singer 1976). For relation of *M. curreyi* and *M. graminum*, see Antonín & Noordeloos (1993).

Marasmius rotalis **var.** ***latisporus*** **Antonín var. nov.** **Figure 3**

A varietate typica basidiosporis latis (7.7–10.1(–10.8) x 4.6–5.4 µm) et stipitibus longis (usque 140 mm) differt.
Holotypus: Burundi, prov. Bururi, Bururi, 7. II. 1979 leg. J. Rammeloo 6577 (holotypus in herbario BR 11930-96 asservatur).

Pileus up to 4 mm broad, campanulate, umbilicate, with less distinct to distinct central papilla, distinctly sulcate, glabrous to minutely granulose, margin crenulate, pale beige, with or without black centre. **Lamellae** moderately distant, L = 14–17, l = 0(–1), collariate, white to whitish, with concolorous edge. **Stipe** very long, up to 140 x 1 mm, filiform, glabrous, smooth, lustrous, insititious, dark brown to black, apex concolorous with lamellae.

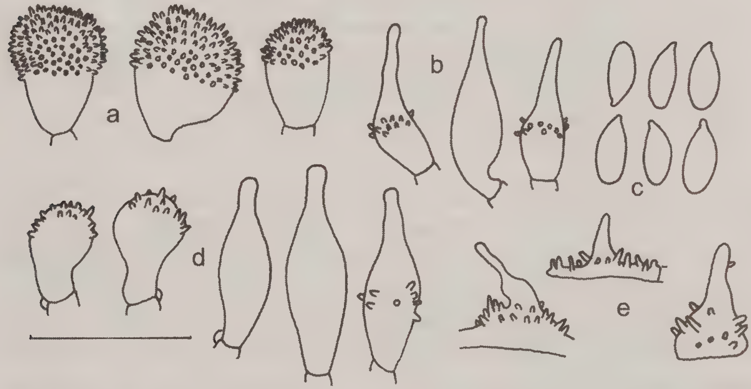

Figure 3. *Marasmius rotalis* var. *latisporus* (holotype): a. pileipellis cells, b. basidiospores, c. cheilocystidia. Scale bar = 20 µm.

Basidiospores 7.7–10.1(–10.8) x 4.6–5.4 µm, E = 1.6–1.9, Q = 1.7, ellipsoid, ellipsoid-fusoid, thin-walled, hyaline, nondextrinoid. **Basidia** not found. **Basidioles** 15–27 x 5.0–10.0 µm, cylindrical, clavate, fusoid. **Cheilocystidia** similar to pileipellis cells, 15–29(–38) x 6.0–17 µm, clavate, thin-walled. **Pleurocystidia** absent. **Trama hyphae** cylindrical, ± thin-walled, nondextrinoid, up to 8 µm wide. **Pileipellis** a hymeniderm made up of broom cells of the Rotalis-type, 11–29 x 7.0–19 µm, thin- or slightly thick-walled, (broadly) clavate, nondextrinoid; projections digitate, obtuse, slightly thick-walled, up to 4.0 x 1.0 µm. **Stipitipellis** a cutis made up of cylindrical, parallel, smooth, dextrinoid, up to 5.0 μm wide hyphae. Stipe medulla hyphae dextrinoid. **Caulocystidia** absent. **Clamp connections** present in all tissues.

Ecology – On dead, fallen leaves.

Distribution – Known only from the type locality in Burundi.

> **REVISED SPECIMEN – BURUNDI:** Bururi Province, Bururi, 7 Feb. 1979 leg. J. Rammeloo 6577 (BR 11930-96).

Comments – *Marasmius rotalis* var. *latisporus* belongs to sect. *Marasmius* and differs from the type variety by having a very long stipe and larger, especially broader basidiospores.

Marasmius subalbidulus Antonín spec. nov. Figure 4

> *Pileo 0,5–1,5 mm lato, convexo vel applanato, centro obtuso, subtiliter sulcato, albo, centro luteolo. Lamellis distantibus, L = 7–9, l = 0-1, breviter adnatis, non-collariatis, albidis, acie concolore. Stipite usque 15 mm longo, insititio, apice albido, basim brunneo. Basidiosporis 8,0–9,5 x 3,5–4,5 μm, ellipsoideis-fusiformibus, hyalinis, inamyloideis. Basidiis tetrasporis. Cheilocystidiis e cullulis similibus cellulis cheilocystidiorum Marasmii rotalis, 12,5–14 x 8,0–9,5 μm, clavatis vel pyriformibus et e cellulis lageniformibus vel fusiformibus, 18–27 x 6,0–9,0 μm. Pleurocystidiis similibus cheilocystidiis typi 2. Pileipellis hymeniformis e cellulis clavatis, ellipsoideis, pyriformibus vel vesiculosis, similibus cellulis hymenidermatis Marasmii rotalis, 13–21 x 9,0–17 μm constructa. Pileocystidiis 18–25 x 6,0–8,0 μm, lageniformibus vel fusiformibus, basin versus cum diverticulis infrequentibus, nonnumquam laevibus. Caulocystidiis 8,0–16 x 3,0–10 μm, lageniformibus vel conicis, basin versus cum diverticulis. Hyphis indextrinoideis, fibulatis.*
> *HOLOTYPUS: Uganda, prov. Buganda, reg. Mengo, silva Mabira, 9. VI. 1968 leg. D.N. Pegler U1376 (holotypus in herbario K(M) 115020 asservatur).*

Neither macroscopic description nor slide available; macrodescription made according to dry carpophores. **Pileus** 0.5–1.5 mm broad, convex to applanate, without central papilla, slightly sulcate; white, with yellowish centre. **Lamellae** distant, L = 7–9, l = 0–1, well-developed, shortly adnate, without collarium; white, edge entire, concolorous. **Stipe** up to 15 mm long, ± filiform, insititious, whitish above, brown towards base. Forming sterile stipes and rhizomorphs.

Basidiospores 8.0–9.5 x 3.5–4.5 μm, E = 1.9–2.3, Q = 2.1, pip-shaped, ellipsoid-fusoid, thin-walled, smooth, hyaline, nondextrinoid. **Basidia** (one found) 16 x 8.0 μm, 4-spored, broadly clavate. **Basidioles** 10–18 x 4.0–8.0 μm, clavate, cylindrical, often fusoid. **Cheilocystidia** of two types: (1) broom cells of the Rotalis-type, 12.5–14 x 8.0–9.5 μm, clavate, pyriform, thin-walled, ± hyaline, nondextrinoid, and (2) lageniform to fusoid, often rostrate, obtuse to subcapitate, 18–27 x 6.0–9.0 μm, ± thin-walled cells, sometimes with scattered diverticula at basal part, nondextrinoid. **Pleurocystidia** in the form of cheilocystidia of type 2. **Hyphae** ± cylindrical, thin-walled, branched, smooth, hyaline, nondextrinoid, up to 8.0 μm wide. **Pileipellis** a hymeniderm made up of clavate, ellipsoid, pyriform to vesiculose, nondextrinoid broom cells of the Rotalis-type, 13–21 x 9.0–17 μm, thin-walled at base, thin- to slightly thick-walled (walls up to 1.0 μm) above, warts ± narrowly conical, subacute to acute, up to 1.5 μm long; thick-walled cells subhyaline to pale yellowish-brownish in KOH. **Pileocystidia** 18–25 x 6.0–8.0 μm, lageniform to fusoid, often rostrate, obtuse to subcapitate, thin- to mostly slightly thick-walled, mostly with some projections in basal parts, sometimes smooth, nondextrinoid, subhyaline or with pale yellow-brown walls in KOH. **Stipitipellis** a cutis made up of parallel, cylindrical, slightly thick-walled, diverticulate, nondextrinoid, up to 5.0 μm wide hyphae, with brown walls in KOH; diverticula up to 2.0 μm long, cylindrical to conical, obtuse to subacute, pale brown to dark brown in KOH. **Caulocystidia** scattered, 8.0–16 x 3.0–10 μm, lageniform or conical, at base with diverticula, slightly thick-walled, nondextrinoid, concolorous with stipitipellis. **Clamp connections** rare, but present in all tissues.

Ecology – Growing on dead leaves.

Distribution – Hitherto known only from Uganda.

REVISED SPECIMEN – UGANDA: Buganda Province, Mengo District, Mabira Forest, 9 June 1968 leg. D.N. Pegler U1376 (holotype, K(M) 115020, as *M. rotalis*).

Comments – *Marasmius subalbidulus* is characterised by having a white pileus, distant lamellae, well-developed, ± lageniform pileo-, cheilo- and pleurocystidia, two types of cheilocystidia and small, lageniform caulocystidia. It belongs to sect. *Hygrometrici*. Although neither a macroscopic description nor slides are available, its features are so distinct that it clearly represents a new species.

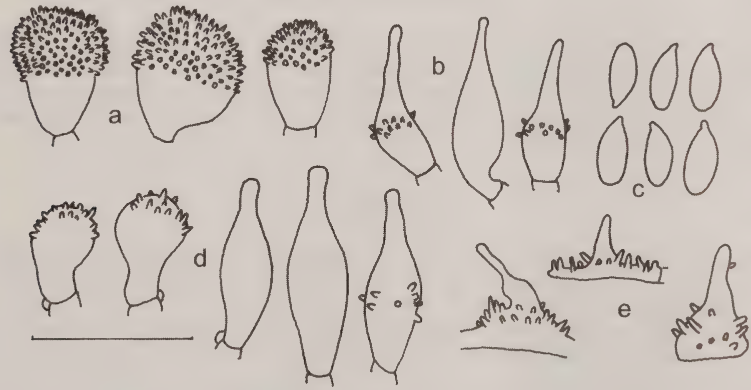

Figure 4. *Marasmius subalbidulus* (holotype): a. pileipellis cells, b. pileocystidia, c. basidiospores, d. cheilocystidia (two types), e. caulocystidia. Scale bar = 20 μm.

The only species from this section with a white pileus becoming pale yellow when dry is *M. dicandidus* Desjardin, Retnowati et E. Horak described from

Bali (Indonesia). It differs in having larger basidiospores (8–10 x 4–5 μm) and lacks cheilo-, pleuro-, pileo- and caulocystidia (Desjardin & al. 2000). Also *M. paucilamellatus* Desjardin & E. Horak, known from Papua New Guinea, is pale coloured. However, it has a pale yellow, then cream-tan pileus, lacking lamellae when young, later distant (L = 3–5), longer and narrower basidiospores ((8.0–)8.5–10(–12) x 3.5–4.0 μm), cheilocystidia in the form of fusoid-mucronate cells, and lacks developed pleuro-, pileo- and caulocystidia (Desjardin & Horak 1997).

New combination

***Setulipes congolensis* (Beeli) Antonín comb. nov.**
Basionym: *Marasmius subsplachnoides* Britzelm. ("Fr.") var. *congolensis* Beeli, Bull. Soc. Roy. Bot. Belg 60: 159. 1928.

Singer (1964, 1965) included this species in sect. *Sicci*. A revision of the type specimen (Democratic Republic of Congo, Equateur Province, Eala, June 1923 leg. M. Goossens-Fontana 108, BR 11421-72) showed, that the only carpophore of the type specimen does not have a hymeniform pileipellis, and undoubtedly belongs to the genus *Setulipes*. However, two other specimens cited in the protologue by Singer (Eala, leg. M. Goossens-Fontana 24, BR A650 and Kipushi, Kipopo, leg. M.C. Schmitz-Levecq 51, BR K243) really belong to sect. *Sicci* and represent *Marasmius sierraleonis* Beeli.

Acknowledgements

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References

Antonín V. 2003a. New species of *Marasmius* (Basidiomycetes, *Tricholomataceae*) from tropical Africa – I. Sect. *Epiphylli, Fusicystiddes, Globulares, Hygrometrici* and *Neosessiles*. Mycotaxon 85: 109-130.

Antonín V. 2003b. New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa - II. *Gloiocephala, Marasmius, Setulipes* and two new combinations. Mycotaxon 88: 53-78.

Antonín V. 2004. New species of marasmioid genera (Basidiomycetes, *Tricholomataceae*) from tropical Africa - III. *Marasmius* sect. *Sicci*. Mycotaxon 89(2): 399-422.

Antonín V., Noordeloos ME. 1993. A monograph of *Marasmius*, *Collybia* and related genera in Europe. Part 1: *Marasmius, Setulipes,* and *Marasmiellus*. Libri Bot. 8: 1-229.

Desjardin DE., Horak E. 1997. *Marasmius* and *Gloiocephala* in the South Pacific Region: Papua New Guinea, New Caledonia, and New Zealand taxa. Part 1: Papua New Guinea and New

Caledonia taxa. Part 2: New Zealand taxa. In: Petrini O., Petrini LE., Horak E. (eds.), Taxonomic monographs of Agaricales II, Bibl. Mycol. 168: 1-152.

Desjardin DE., Retnowati A., Horak E. 2000. Agaricales of Indonesia. 2. A preliminary monograph of *Marasmius* from Java and Bali. Sydowia 52(2): 92-194.

Singer R. 1964. *Marasmius* congolais receuillis par Mme Goossens-Fontana et d´autres collecteurs belges. Bull. Jard. Bot. Brux. 34: 317-388.

Singer R. 1965. *Marasmius*. in: Fl. Iconog. Champ. Congo, Vol. 14: 253-278. Bruxelles.

Singer R. 1976. *Marasmiae* (Basidiomycetes, *Tricholomataceae*). Fl. Neotrop. Monogr. 17: 1-347.

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Sebacinoid species from the Pakaraima Mountains of Guyana

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Abstract—Two sebacinoid basidiomycetes, possibly ectomycorrhizal with *Dicymbe corymbosa (Caesalpiniaceae),* are reported from the Pakaraima Mountains of western Guyana. One is a *Tremellodendron* species, for which the new combination *T. ocreatum* is proposed. The other is a *Sebacina* species indistinguishable from the cosmopolitan *S. incrustans.*

Key Words—Neotropics, biodiversity, fungi, Guiana Shield

Introduction

As part of a project to survey macromycetes of Guyana's Pakaraima Mountains, collections were made of two sebacinoid basidiomycetes, possibly ectomycorrhizal with *Dicymbe corymbosa* Spruce ex. Benth. *(Caesalpiniaceae).*

The area surveyed consists of extensive, primary seasonal evergreen rain forest in the Upper Potaro River Basin near the common border with Venezuela and Brazil (general area 5°N 59°W). Research site descriptions and survey methods have been published previously concerning the *Boletaceae* (Henkel 1999), *Amanitaceae* (Simmons et al. 2001), *Clavulinaceae* (Thacker & Henkel 2004), *Cortinariaceae* (Matheny et al. 2003), *Russulaceae* (Henkel et al. 2000; S.L. Miller et al. 2001), *Aphyllophorales* (Aime et al. 2003), and *Elaphomycetaceae* (O.K. Miller et al. 2001).

One of the two sebacinoid taxa collected is a species of *Tremellodendron* Atk., a small genus of clavarioid or ramarioid form in the family *Sebacinaceae*. *Tremellodendron* is confined to the New World, with the majority of species and collections from continental North America, and a minority from the Caribbean, Central and South America. The genus was monographed by Burt (1915) and Bodman (1942), but lacks a modern treatment. Species of *Tremellodendron* are currently distinguished on field characters, but these are "extremely variable" (Bodman 1942) depending on age and conditions of growth. Microscopic characters are readily distinguished for the genus, but vary little between species. Despite this, the collection from Guyana appears distinct.

The second Guyanese taxon is an effused *Sebacina* species, morphologically indistinguishable from the cosmopolitan *Sebacina incrustans* (Pers.:Fr.) Tul. This is the first report of *S. incrustans* in Guyana.

Herbaria designations are according to Holmgren et al. (1990): BRG – University of Guyana, Georgetown; K – Royal Botanic Gardens, Kew, U.K; BPI – U.S. National Fungus Collections. Color designations, noted in parentheses, are from Kornerup and Wanscher (1981).

In the following descriptions, color and habitat details for each species were taken from the collectors' field notes. Dried specimens were mounted in 5% ammonia solution for examination by light microscopy. Illustrations of microscopic details were made using a Leitz Wetzlar drawing tube.

Taxonomy

Tremellodendron ocreatum (Berk.) P. Roberts, comb. nov. Figs. 1, 2

Thelephora ocreata Berk. in Hooker's J. Bot. 8: 238 (1856)

Basidiomata terrestrial, solitary, 40–80 mm tall, branching from the base; branches cylindrical, ascending, non-anastomosing, dividing 4–5 times, the tips acute; entirely white when fresh, infertile surfaces matted or downy, the hymenium more polished; pale ochraceous buff when dried, the hymenium pale tan, greying with age. *Hyphae* hyaline to yellow-brown, 2–3 μm wide, sparsely branched, thick-walled, lacking clamp-connections. *Hyphidia* not seen. *Cystidia* absent. *Basidia* tremelloid, subglobose to ellipsoid, occasionally short-stalked and broadly clavate, 10–13 x 7.5–9 μm. *Sterigmata* four, not clearly seen. *Basidiospores* oblong (Q = 1.5–2.1), sometimes ventrally depressed, 7–10 x 4–5.5 μm.

Specimens examined. BRAZIL: Amazonas, São Jeronimo (formerly Panuré), amongst dead leaves, 1853, *R. Spruce* 11 (ex herb. M.J. Berkeley), holotype, K(M) 8527; same details (ex herb. J. Hooker), isotype, K(M) 8528; GUYANA: Region 8 Potaro-Siparuni, Pakaraima Mountains, Upper Potaro River Basin, under *Dicymbe corymbosa*, 2 July 2002, *T. Henkel* TH 8518 (also K(M) 116793 and BRG); same details, *Dicymbe*-2 plots, frequent, scattered under *D. corymbosa*, 19 June 2002, *M.C. Aime* MCA 2069 (BPI 843411).

Commentary. Corner (1968) noted that *Thelephora ocreata* was a *Tremellodendron* species, but did not recombine the name. We concur with Corner's earlier observation. Basidium and spore morphologies, as well as coralloid macromorphology, clearly align *T. ocreata* with *Tremellodendron* of the *Sebacinaceae*. The description above is taken from the type collections and Berkeley's original account. Based on examination of the types and our Guyanese collections, the salient features of this species within *Tremellodendron* are the lack of anastomosis in the stipe or branches, the more or less cylindrical cross-section of the branches, and their acute, not flattened, tips.

The most common North American species, *Tremellodendron candidum* (Schwein.) Atk. and *T. schweinitzii* (Peck) Atk. (= *T. pallidum* nom. illeg.), are of similar colour and stature but differ inter al. in being highly anastomosed and having flattened, non-acute branch apices. This was noted by Berkeley (1856), who characterized his new species as "resembling *Thelephora candida* Schwein., but without any tendency to be compressed. Much divided forms of *T. pallida* Schwein. also approach it, but there is little doubt that it is distinct."

Of the remaining branched species, *Tremellodendron cladonia* (Schwein.) Burt and *T. tenax* (Schwein.) Burt both have variously flattened branches, *T. tenue* Burt is very sparsely branched, and *T. merismatoides* (Schwein.) Burt has acute but fine, hair-like branches. All are said to be much smaller (under 60 mm high fide Bodman, 1942) than *Tremellodendron ocreatum*.

The Guyanese material differs from the type specimens of *T. ocreatum* primarily in that the basidiomata may reach up to 110 mm tall. All were white to cream (4A2-4A3) when fresh, drying pale buff (4A4). In some basidiomata, however, the hymenium became thickened and dark grey (5C3) when fresh, possibly a factor of age or maturation. Microscopically, branched hyphidia and mature basidia with four flexuose sterigmata are readily apparent (both collapsed in the type specimens); basidiospores measured 7.5–10 x 5–6 μm. It is possible that the Guyanese collection represents a distinct taxon with a graying hymenium, but for the moment it seems best referred to *Tremellodendron ocreatum* which agrees both macroscopically and microscopically in every other respect.

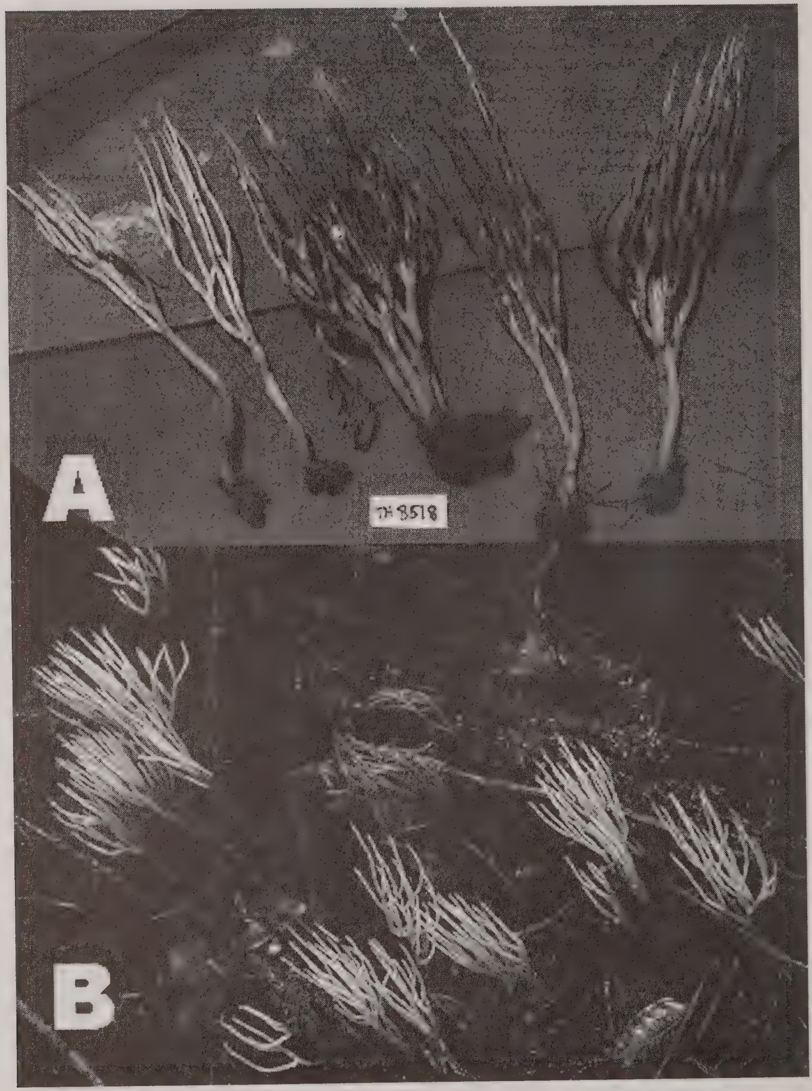

Fig. 1. Basidiomata of *Tremellodendron ocreatum*. A. *Henkel 8518* (× 0.65) B. Field habit under *Dicymbe corymbosa* (× 0.4)

Recent studies have shown that members of the *Sebacinaceae* are important components of the ectomycorrhizal mycota in temperate regions (Selosse et al. 2002, Urban et al. 2003). An ectomycorrhizal habit is also presumed for *Tremellodendron ocreatum* which, in the Pakaraima Mountains, fruits abundantly and exclusively under the ectomycorrhizal *Dicymbe corymbosa* (Henkel et al. 2002). A Nuclear-LSU sequence for *T. ocreatum* has been obtained and deposited in GenBank (MCA 2069; AY393696) that confirms its affinities with members of the *Sebacinaceae*.

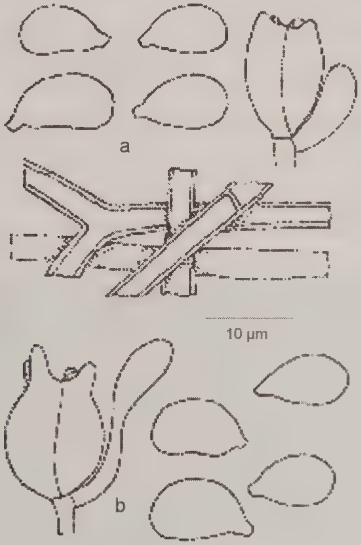

Fig. 2. *Tremellodendron ocreatum*. a) basidiospores, immature basidium, and subhymenial hyphae (isotype); b) basidium and basidiospores (*Henkel 8518*)

Sebacina incrustans (Pers.: Fr.) Tul. in *J. Linn. Soc. Bot.* 13: 36 (1871)Fig. 3

Basidiomata effused, incrusting, on fallen twigs and leaves, and living rootlets, saplings, and stems, smooth, tough, sordid greyish (5D3-5C2) when fresh, drying pale ochraceous. *Hyphae* hyaline, 2.5 - 3.5 μm wide, sparsely branched, thick-walled, lacking clamp-connexions. *Hyphidia* weakly branched. *Cystidia* absent. *Basidia* tremelloid, ellipsoid, occasionally short-stalked and broadly clavate, 15–18 x 10–12.5 μm. *Sterigmata* four, flexuose. *Basidiospores* oblong (Q = 1.4–1.9), 10–12.5 (- 13.5) x 6–8.5 μm.

Specimens examined. ENGLAND: Devon, Dunsford Woods, encrusting litter and twigs, 30 Aug. 1992, *P. Roberts* 424, K(M) 116587; GUYANA: Region 8 Potaro-Siparuni, Pakaraima Mountains, Upper Potaro River Basin, under *Dicymbe corymbosa*, 23 June 2002, *T. Henkel* 8484 (K(M) 116794 and BRG); same details, *Dicymbe*-2 plots, covering rootlets, stems and lower portion of saplings, 12 June 2002, *M.C. Aime* 1975 (BPI 843410).

Commentary. The Guyanese material, described above, is, for the most part, indistinguishable from temperate collections of *Sebacina incrustans*. This is a species originally described from Europe and possibly cosmopolitan, having been reported from Central America and Trinidad by Lowy (1971). A typical collection from England (selected for comparison and cited above) was "sordid greyish-white" when fresh and had basidiospores (from a print) measuring 10–15 x 6.5 - 8.5 μm (Q = 1.4–1.9). Some temperate collections of *S. incrustans* (e.g. McGuire, 1941) have been described as having more acutely branched, tortuous hyphidia than those observed in the Guyanese material.

Sebacina incrustans is known to be ectomycorrhizal with *Picea abies* (Urbanet al. 2003) and it is probable that, like *Tremellodendron ocreatum*, *S. incrustans* is also ectomycorrhizal with *Dicymbe corymbosa* in Guyana, where it is a commonly encountered in *D. corymbosa*-dominated forests.

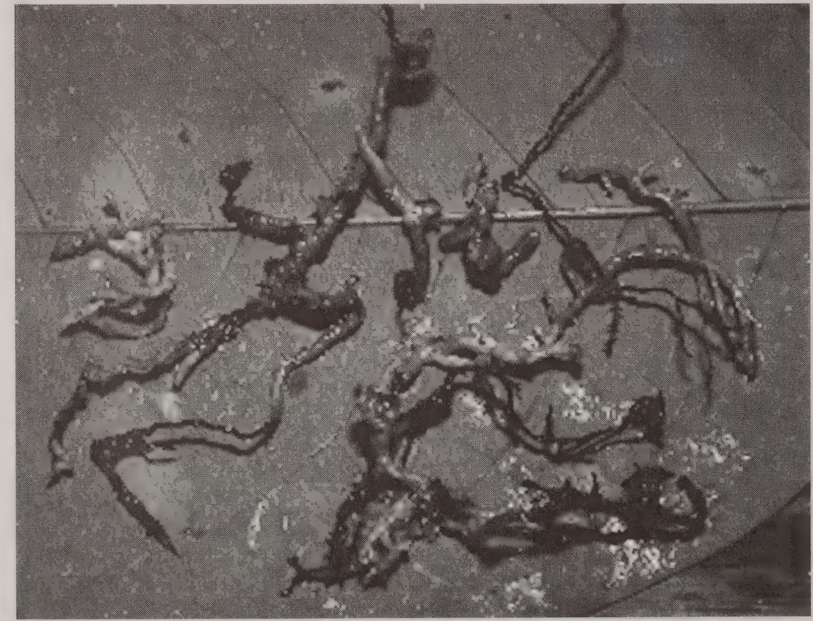

Fig. 3. Basidiomata of *Sebacina incrustans, Aime 1975*, showing field habit of effused, incrusting growth over living and dead plant rootlets and stems

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Literature cited

Aime MC, Henkel TW, Ryvarden L. 2003. Studies in Neotropical polypores 15. New and interesting species from Guyana. Mycologia 95: 614-619.

Berkeley MJ. 1856. Decades LIX - LX. Rio Negro fungi. Hooker's Journal of Botany 8: 233-241.

Bodman MC. 1942. The genus *Tremellodendron*. American Midland Naturalist 27: 203-216.

Burt EA. 1915. The *Thelephoraceae* of North America. Annals of the Missouri Botanical Garden 2: 731-771.

Corner EJH. 1968. A monograph of *Thelephora*. Beihefte Nova Hedwigia 27: 1-110 + 6 pl.

Henkel TW. 1999. New taxa and distribution records of *Tylopilus* from *Dicymbe* forests of Guyana. Mycologia 91: 655-665.

Henkel TW, Aime MC, Miller SL. 2000. Systematics of pleurotoid *Russulaceae* from Guyana and Japan, with notes on their ectomycorrhizal status. Mycologia 92: 1119-1132.

Henkel TW, Terborgh J, Vilgalys R. 2002. Ectomycorrhizal fungi and their leguminous hosts from the Pakaraima Mountains of Guyana. Mycological Research 106: 516-532.

Holmgren P, Holmgren N, Barnett LC. 1990. Index Herbariorum part I. The herbaria of the world. New York: New York Botanical Garden. 693 p.

Kornerup A, Wanscher JH. 1981. Methuen handbook of colour. 3rd ed. London: Eyre Methuen. 252 p.

Lowy B. 1971. *Tremellales*. (Flora Neotropica 6). New York: New York Botanical Garden. 153 pp.

Matheny B, Aime MC, Henkel TW. 2003. New species of *Inocybe* from Guyana. Mycological Research 107: 495-505.

McGuire JM. 1941. The species of *Sebacina* (Tremellales) of temperate North America. Lloydia 4: 1-43.

Miller OK Jr., Henkel TW, James TY, Miller SL. 2001. *Pseudotulostoma*, a remarkable new volvate genus in the *Elaphomycetaceae* from Guyana. Mycological Research 105: 1268-1272.

Miller SL, Aime MC, Henkel TW. 2001. The *Russulaceae* of the Pakaraima Mountains of Guyana. I. New species of pleurotoid *Lactarius*. Mycologia 94: 545-553.

Selosse M, Bauer R, Moyersoen B. 2002. Basal hymenomycetes belonging to the *Sebacinaceae* are ectomycorrhizal on temperate deciduous trees. New Phytologist 155:183-195.

Simmons C, Henkel TW, Bas C. 2001. The genus *Amanita* in the Pakaraima Mountains of Guyana. Persoonia 17: 563-582.

Thacker J, Henkel TW. 2004. New species of *Clavulina* from Guyana. Mycologia (in press).

Urban A, Weiss M, Bauer R. 2003. Ectomycorrhizas involving sebacinoid mycobionts. Mycological Research 107: 3-14.

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Comparative analysis of common indoor *Cladosporium* species based on molecular data and conidial characters

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Abstract—ITSs and D1/D2 regions of the LSU rRNA genes of 57 ATCC strains of *Cladosporium* representing common airborne species, *C. herbarum, C. cladosporioides* and *C. sphaerospermum,* were PCR-amplified and sequenced in both directions. Sequence alignments and subsequent maximum parsimony analyses on both of the datasets indicated that *C. herbarum* and *C. cladosporioides* were more closely related to each other than either was to *C. sphaerospermum.* Most strains were clustered into one of the three individual groups according to the species identification by the depositors. However, four strains deposited as *C. herbarum* clustered with *C. clasdosporioides.* Conidial shapes of these four strains resembled *C. herbarum* although their size was smaller. Another strain deposited as *C. cladosporioides* clustered with *C. herbarum.* The conidia of this strain were longer than the typical conidia of *C. cladosporioides*, but resembled *C. cladosporioides.* ATCC 64726 (deposited as *C. cladosporioides*) and ATCC 26362 (deposited as *C. herbarum*) were placed close to *C. sphaerospermum*, but formed a distinct subgroup with strong bootstrap supports. The strains of these three *Cladosporium* species collected over a wide range of areas displayed minute intra-species sequence variations and varying degrees of conidial shapes and sizes.

Key words—Airborne *Cladosporium*, rDNA

Introduction

Conidia of *Cladosporium herbarum* (Pers.:Fr.) Link, *C. cladosporioides* (Fresen.) G. A. de Vries and *C. sphaerospermum* Penz. are some of the most ubiquitous bioaerosols found in indoor and outdoor samples (Al-Doory 1984, Domsch et al. 1980, Mullins 2001, Shelton et al. 2002). *C. herbarum* has been implicated as a potential cause of human health problems such as allergy, irritation and infection (Horner et al. 1995). *C. sphaerospermum* and *C. cladosporioides* are two of the most reactive species against patients with allergy, rhinitis and asthma (Tarlo et al. 1988). It also has been shown that *C. sphaerospermum* contained toxigenic compounds to humans (David et al. 1975). Despite the abundance of *Cladosporium* spores in the environment and their medical implications, molecular and morphological protocols for identification of *Cladosporium* isolates to species level still require substantial improvement. Frequently, published taxonomic profiles of airborne fungal samples have been determined largely at genus level due to the lack of easily identifiable morphological characters and limited DNA sequence information at species level. Although keys were proposed to identify species based on morphology, host and substrate utilization (deVries 1952; de Hoog et al. 2000; David 1997; Domsch et al. 1980; Samson et al. 2000), frequently morphological descriptions were not clear-cut, sizes of reproductive structures tend to overlap among the different taxa and many descriptive terms are often vague. An expanded key recently proposed by Ho et al. (1999) differentiated the three species according to shape, size and ornamentation of conidia, and characters of conidiophores. They did use characters of chlamydospores to identify some species, but chlamydospores were not important for *C. herbarum*, *C. cladosporioides*, or *C. sphaerospermum.*

In 2002, Wirsel et al. estimated the phylogenetic relationship with a few ITS sequences from GenBank among strains of *C. cladosporioides*, *C. herbarum* and *C. sphaerospermum* and found that these strains were almost indistinguishable. In 2003, Braun et al. proposed to erect the teleomorphic genus *Davidiella* and to confine *Cladosporium* to anamorphs of *Davidiella* with coronate conidiogenous loci and conidial hila and to assign many *Cladosporium*-like hyphomyces to other genera. The anamorphs of proposed *Davidiella* include three major airborne *Cladosporium* species, *C. herbarum*, *C. cladosporioides* and *C. sphaerospermum*. It has been known that conidia of *C. herbarum* are bigger than *C. cladosporioides* and the conidia of *C. sphaerospermum* are predominantly globose and often enveloped by a membrane (de Vries 1952).

In this study, the sequences of the D1/D2 regions of the LSU rRNA genes and the ITS regions of the rDNA were employed in order to establish molecular standards for the demarcation of the three species: *C. herbarum, C. cladosporioides* and *C. sphaerospermum.* At the same time, comparative assessment of the shape and size of conidia was also performed for these species.

Materials and Methods

Cultivation of strains

Fifty-seven strains of *Cladosporium* were obtained from the cryopreserved seed stocks at ATCC (Table 1). For the study, the strains were cultivated using six solid agars and broth media at 25°C or 30°C for approximately seven days. The media formulations included Blakeslee's formula (ATCC # 325): malt extract 20g, glucose 20g, peptone 1g and agar 20g per liter; PDA (ATCC # 336): diced potatoes 300g, glucose 20g and agar 15g per liter; Emmon's modification of Sabouraud's agar (ATCC # 28): Sabouraud's glucose broth 30g and agar 20g per liter; Harrold's M40Y (ATCC # 319): malt extract 20g, yeast extract 5g, sucrose 400g and agar 20g per liter; malt agar (ATCC # 323): Difco 0024; and malt extract agar (ATCC # 324): malt extract 20g, peptone 5g and agar 15g per liter.

Isolation of genomic DNA

Genomic DNAs from 57 strains of *C. herbarum*, *C. cladosporioides*, *C. sphaerospermum* and other species were isolated according to the method of Cenis (1992). Mycelia were pelleted by centrifugation at 13,800×g for 5 minutes, placed in yeast lysis matrix tubes (Bio101, Vista CA) and subjected to vigorous agitation in a FastPrep FP120 shaker (Bio101, Vista, CA) for two 40-second intervals at a speed setting 4.0 m/s. RNase (0.25µl in concentration of 0.5µg/µl, Boehringer Mannheim, Indianapolis IN) was added to 50µl final volume of DNA and the mixture was incubated for 30 minutes at 30°C. Prior to PCR, the concentration of genomic DNA was determined by comparing band intensity with molecular weight standard on agarose gel and UV absorbency at 260nm measured by a GeneQuant Pro RNA/DNA calculator (Biochrom, Cambridge, UK). Isolated genomic DNA was stored in a –80°C freezer.

PCR

The D1/D2 regions of the LSU rRNA genes, putatively located along 63 through 633 relative to the 5'-end of *Saccharomyces cerevisiae* LSU rRNA gene (Georgiev et al. 1981), were PCR-amplified with two primers, F63: gctgaacttaagcatatcaataagcggaggaaa and R635: tagactccttggtccttt tcaagacgggc (O'Donnell 1993). ITS regions of rDNA were amplified with NS7 and LR3 primers, NS7: gaggcaataacaggtctgtgatgc and LR3: ccgtgtttcaagacggg (Vilgalys and Gonzalez 1990). Each of the 50µl PCR reaction mixtures consisted of two "Ready-to-Go" PCR beads (Amersham Pharmacia Biotech, Piscataway, NJ), 4µl of template genomic DNA (20ng), 1µl of each primer (10 pmol) and 44µl of deionized H_2O. The amplifications were carried out using a GeneAmp PCR system 9700 thermal cycler (Applied Biosystems, Foster City, CA) with the following parameters: Initial denaturation at 94°C for 5 min, 30 cycles of 94°C for 30 sec, 55°C for 2 min, 72°C for 2 min and an additional 72°C for 5min prior to maintaining the mixture at 4°C (O'Donnell 1993). DNA molecules of about 600 nucleotides were amplified and the PCR products were cleaned with Qiagen gel extraction kit by following the manufacturer's protocol (Qiagen Inc., Chatsworth, CA).

DNA sequencing

The cycle sequencing reactions were carried out using a Big Dye terminator cycle sequencing ready reaction kit (Applied Biosystems, Foster City CA). The reaction mixtures consisted of 4 µl (50 ng) of DNA template, 0.5 µl of primer (5 pmol), 8 µl of Big Dye terminator and 7.5 µl of deionized H_2O for a total volume of 20 µl. The cycle sequencing program was as follows: Initial denaturation at 95°C for 5min, 25 cycles at 95°C for 30 sec, 50°C for 30 sec, 60°C for 2 min and an additional 60°C for 7 min prior to storing the sample at 4°C. The extension products were purified with Centri-Sep spin columns (Princeton Separations, Adelphia, NJ) prior to being loaded onto an ABI 377 automated sequencer (Applied Biosystems, Foster City, CA). Sequencing gel (5% acrylamide) was cast with LongRanger Singel packs (BioWhittaker Molecular Applications, Rockland, ME). The sequences were tracked and extracted with the ABI Prism 377-96 data collection software. Primers F63, R635, NL2 (ctctcttttcaaagttcttttcatct) and NL3 (agataaaaagaacttt gaaaagagag) were used for sequencing the D1/D2 regions of LSU rRNA genes (O'Donnell 1993). Primers ITS 1 (tccgtaggtgaacctgcgg) and ITS 4 (tcctccgcttattgatatgc) were used for sequencing the ITS region (White et al. 1990; Gardes and Bruns 1993). Two sequences in different direction for each strain were compared and any mismatching nucleotides were corrected by comparing them with the electropherograms. Sequence information was submitted to GenBank, National Center for Biotechnology Information (NCBI, http://www.ncbi.nlm. nih.gov/).

Sequence alignment and phylogenetic analysis

The sequences were aligned with CLUSTALX (Thompson et al. 1997). Phylogenetic relationships were estimated with PAUP 4.0b4a (Swofford 2000). For alignments with CLUSTALX, the gap opening cost and the gap extension cost were set between 2 and 16 in increments of 2. All nucleotides were unordered and given equal weights. Gaps were considered as missing bases and heuristic searches were carried out with the branch swapping option using the tree-bisection-reconnection algorithm. Starting trees were obtained via stepwise addition and branches of maximum length zero were allowed to collapse yielding polytomies.

The sequences of *Mycosphaerella juvenis* (AF309586), *M. suttoniae* (AF309587) and *M. heimioides* (AF309577) from GenBank were included in the data set of the D1/D2 regions of the LSU rRNA genes. The sequence of *M. juvenis* was chosen as outgroup. Four sequences of *C. cladosporioides* (AF455525, AF455535, AF455472 and AF455517), two sequences of *C. herbarum* (AF455404 and AF455517) and one sequence of *C. sphaerospermum* (AF455481) from GenBank were added to the ITS data set. The sequences of *Cladophialophora bantiana* (Saccardo) de Hoog et al. (AF397182), *M. graminicola* (Fuckel) Sanderson (AJ300330) and *Septoria passerinii* Saccardo (AF181697) from GenBank were also added to the ITS data set to estimate relative phylogenetic relationship to the three *Cladosporium* species.

Results

Sequence alignment and maximum parsimony analysis on the 56 D1/D2 sequences of 575 characters clustered the *Cladosporium* strains into three major clades. The first clade included 24 *C. cladosporioides* strains and three strains deposited as *C. herbarum* (ATCC 58927, ATCC 60569 and ATCC 6506). The second clade included 16 *C. herbarum* strains and ATCC 201105. The third group consisted of four *C. sphaerospermum* and one subgroup of ATCC 26362 and ATCC 64726. Out of 575 total characters, 397 were constant, 63 were parsimony-uninformative and 115 were parsimony-informative. The sequences were mostly consistent within each of the three species. *C. herbarum* and *C. cladosporioides* differed by 3 nucleotides. *C. herbarum* and *C. cladosporioides* differed from *C. sphaerospermum* by 13 and 14 nucleotides respectively. These three species formed one lineage (Figs. 2 and 3). Six strains were aberrant in their placement with regard to other strains of the same name (Fig. 2). The sequences of *C. herbarum* and *C. sphaerospermum* were almost identical among the strains of each group in ITS and D1/D2 region of the genes. In contrast, the ITS sequences of six strains identified as *C. cladosporioides* varied by as many as three nucleotides from the other strains of the species. As before, ATCC 26362, ATCC 6506, ATCC 58927, ATCC 28987, ATCC 201105, ATCC 64726 and ATCC 60569 failed to cluster with the majority of the strains of the species (Fig. 3). ATCC 6506, ATCC 58927, ATCC 28987 and ATCC 60569 clustered with *C. cladosporioides* while ATCC 26362 and ATCC 64726 formed a subgroup closely located to the group of *C. sphaerospermum*. ATCC 201105 was clustered with *C. herbarum* (Fig. 3). Out of 631 total characters, 324 were constant, 110 variables were parsimony-uninformative and 197 variables were parsimony-informative. Morphologically, the shapes and sizes of the conidia of the most strains conformed to published species descriptions (Fig. 1).

Table 1 Strains of *Cladosporium*, their GenBank accession numbers and places of isolation

Species Name	ATCC Number	GenBank Accession Number		Place of Isolation
		D1/D2 region	ITS region	
C. cladosporioides	11275	AY 342060	AY 361960	
	26688	AY 342062	AY 361962	Florida,USA
	38494	AY 342064	AY 351963	
	42198	AY 342065	AY 361964	WestIndies
	58227	AY 342066	AY 361964	Florida,USA
	58991	AY 342067	AY 361966	Maryland,USA
	60549	AY 342068	AY 361967	New Zealand
	64726	AY 342069	AY 361968	Georgia,USA
	66468	AY 342070	AY 361969	Maryland, USA
	201092	AY 342071	AY 463363	Washington, USA
	201095	AY 342072	AY 361970	Washington,USA
	201105	AY 342073	AY 361971	Washington,USA
	201140	AY 342074	AY 361972	Brazil
	201141	AY 342075	AY 463364	Brazil
	201142	AY 342076	AY 361973	Brazil
	6721	AY 342077	AY 361995	Canada
	66669	AY 342110	AF393689	New York, USA
	34668	AY 342079	AY 463365	Idaho, USA
	38810	AY 342080	AY 361997	Denmark
	62295	AY 342081		Illinois,USA
	62732	AY 342082	AY 361996	NorthDakota,USA
	201103	AY 342083	AY 361957	Washington,USA
	201102	AY 342107	AF393687	Washington,USA
	201098	AY 342108	AF393688	Washington,USA
	11277	AY 342113	AF393690	UnitedKingdom
	200941	AY 342114	AF393691	theNetherlands
C. herbarum	6506	AY 342084	AY 361974	
	26361	AY 342086	AY 361981	NewJersey,USA
	26362	AY 342087	AY 361982	NewJersey,USA
	58927	AY 342088	AY 361984	Maryland,USA
	60569	AY 342090	AY 361985	Israel
	62720	AY 342091	AY 361986	NorthDakota,USA
	66670	AY 342092	AY 361959	New York, USA
	66671	AY 342093	AY 463366	New York, USA
	76226	AY 342094	AY 361987	California,USA
	201090	AY 342095	AF393705	Washington,USA
	201096	AY 342096	AY 361975	Washington,USA
	201100	AY 342097	AY 361976	Washington,USA
	201101	AY 342098	AY 361977	Washington,USA
	201852	AY 342099	AY 361978	Idaho,USA
	201853	AY 342100	AY 361979	Idaho,USA
	201855	AY 342101	AY 361980	Washington,USA
	11281	AY 342106	AF393707	theNetherlands
	201091	AY 342109	AF393706	Washington,USA
	201093	AY 342111	AF393703	Washington,USA
	201094	AY 342112	AF393704	Washington,USA

Table 1 Continued

Species Name	ATCC Number	GenBank Accession Number		Place of Isolation
		D1/D2 region	ITS region	
	201854		AY 361993	
	28987		AY 361983	
C. sphaerospermum	12092	AY 342102	AY 361988	Canada
	11288	AY 342103	AY 361989	
	11289	AY 342104	AY 361958	
	11290	AY 342105	AY 361990	
	11293		AY 361992	
	200384		AY 361991	
C. breviramosum	64696	AY 345902	AF393684	
Arthrinium sacchari	76303	AY 345898	AF393679	
Amorphotheca resinae	200942	AY 352592	AF393726	

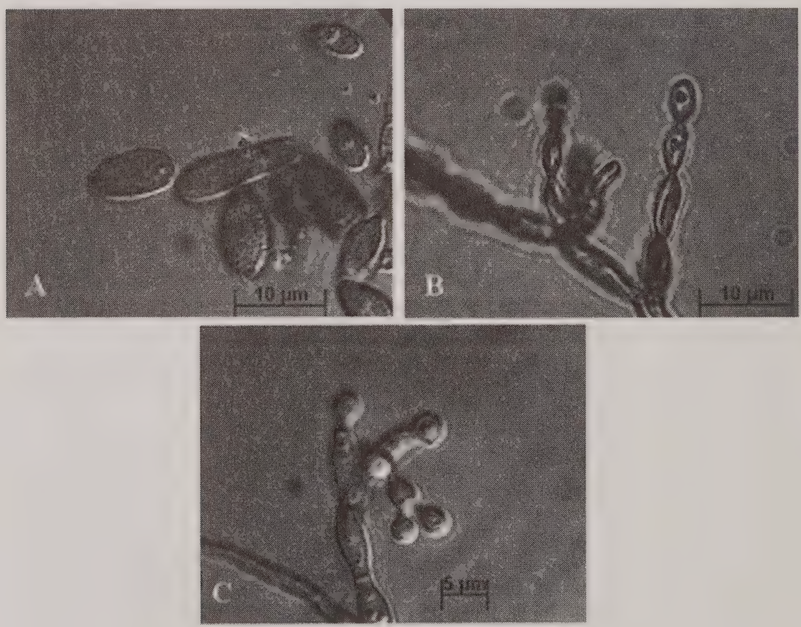

Fig. 1. Conidia of (a) *C. herbarum* ATCC 201094, (b) *C. cladosporioides* ATCC 11275 and (c) *C. sphaerospermum* ATCC 200384 observed with 1000 x magnification

Discussion

The most common airborne *Cladosporium* species, *C. herbarum, C. cladosporioides* and *C. sphaerospermum*, have been identified according to size and ornamentation of conidia, shape of conidiophore and degree of branching of conidial chains. However, even with pure cultures, observing naturally branched conidia or mycelium is relatively difficult and laborious. Furthermore, descriptions of morphological characters such as ornamentation and color of conidia and degree of branching of conidial chains are not clear-cut in many cases. In this study, the great majority of the strains within *C. cladosporioides*, *C. herbarum* and *C. sphaerospermum* were tightly grouped with the strains of the same name in trees derived from the D1/D2 and ITS sequence analyses. However, strain ATCC 201105, which was deposited as *C. cladosporioides*, was clustered with *C. herbarum*. The strains ATCC 58927, ATCC 6506 and ATCC 60569, which were deposited as *C. herbarum* were clustered with *C. cladosporioides*. Morphological observations of the conidia showed that the conidial shapes of these strains were congruent with the species designations provided by the depositors, although molecular information classified them as *C. cladosporioides*. The conidia of these three strains were smaller, 4.0-7.7x 3.0-3.5 μm, than *C. herbarum* (Fig. 1a). The conidia of ATCC 201105, which were longer (11.5-14.5 μm) but more ellipsoidal than *C. herbarum*, resemble *C. cladosporioides* (Fig. 1b) in shape while the molecular analysis clustered this strain as *C. herbarum*. The sequence analyses for the strains ATCC 64726 and 26362 also demonstrated that these two strains are related to *C. sphaerospermum* but separate from *C. sphaerospermum*. The conidia of ATCC 64726 were globose and similar to *C. sphaerosermum* (Fig. 1c). The strain ATCC 26362 did not produce any spores on malt extract agar. These two strains were distinct from *C. sphaerospermum* in terms of nucleotide variation and could be a separate taxon. The molecular methods described here certainly aid in resolving some questions pertaining to the identification of certain isolates that are difficult to differentiate on the basis of morphology. For example, David (1997) was of the opinion that ATCC 201100 (CV10-92a) was misidentified by Dugan and Roberts (1994), who assigned this strain to *C. herbarum*. This study shows that the duo's initial assignment was correct based upon the sequence analyses (Figs. 2 and 3). However, Roberts and Dugan were also the source of ATCC 201105, identified as *C. cladosporioides* and here clustering with *C. herbarum* (Figs. 2 and 3). ATCC 201100 (Dugan and Roberts 1994) is representative of *Cladosporium* isolates with conidia somewhat larger and more roughened than is typical of *C. cladosporioides*, but whose conidiophores are not conspicuously nodose and/or geniculate as is typical of *C. herbarum*. Accurate identification of such strains on the basis of

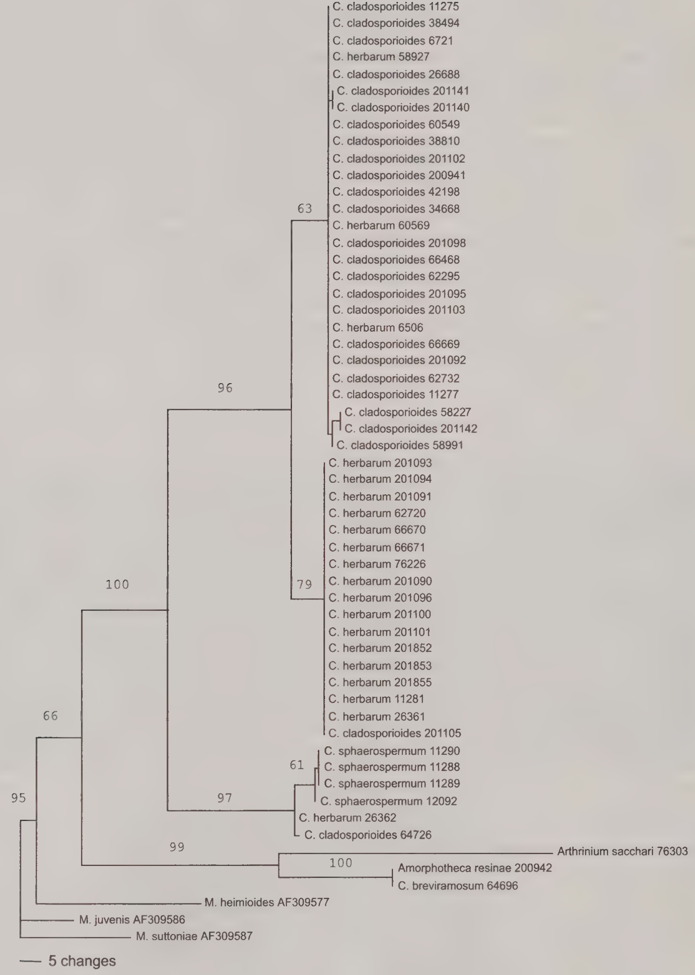
C. cladosporioides 11275
C. cladosporioides 38494
C. cladosporioides 6721
C. herbarum 58927
C. cladosporioides 26688
C. cladosporioides 201141
C. cladosporioides 201140
C. cladosporioides 60549
C. cladosporioides 38810
C. cladosporioides 201102
C. cladosporioides 200941
C. cladosporioides 42198
63
C. cladosporioides 34668
C. herbarum 60569
C. cladosporioides 201098
C. cladosporioides 66468
C. cladosporioides 62295
C. cladosporioides 201095
C. cladosporioides 201103
C. herbarum 6506
C. cladosporioides 66669
C. cladosporioides 201092
96
C. cladosporioides 62732
C. cladosporioides 11277
C. cladosporioides 58227
C. cladosporioides 201142
C. cladosporioides 58991
C. herbarum 201093
C. herbarum 201094
C. herbarum 201091
C. herbarum 62720
C. herbarum 66670
C. herbarum 66671
C. herbarum 76226
100
79
C. herbarum 201090
C. herbarum 201096
C. herbarum 201100
C. herbarum 201101
C. herbarum 201852
C. herbarum 201853
C. herbarum 201855
C. herbarum 11281
66
C. herbarum 26361
C. cladosporioides 201105
C. sphaerospermum 11290
61
C. sphaerospermum 11288
C. sphaerospermum 11289
95
97
C. sphaerospermum 12092
C. herbarum 26362
C. cladosporioides 64726
99
Arthrinium sacchari 76303
100
Amorphotheca resinae 200942
C. breviramosum 64696
M. heimioides AF309577
M. juvenis AF309586
M. suttoniae AF309587
5 changes

Fig. 2. Maximum parsimony tree generated with the dataset of D1/D2 region of LSU rRNA genes of *C. herbarum, C. cladosporioides, C. sphaerospermum* species and several other related species. *M. juvenis* (AF309586) was chosen as outgroup. Ingroup included 55 taxa. For the strains that were sequenced by this lab, ATCC number of each strain is specified after the species name. Three sequences of *Mycosphaerella* species were obtained from GenBank and are specified after species name in the tree. Bootstrap values larger than 50 percent at 1000 replicates are shown at each node. Bootstrap values less than 50 percent are not shown.

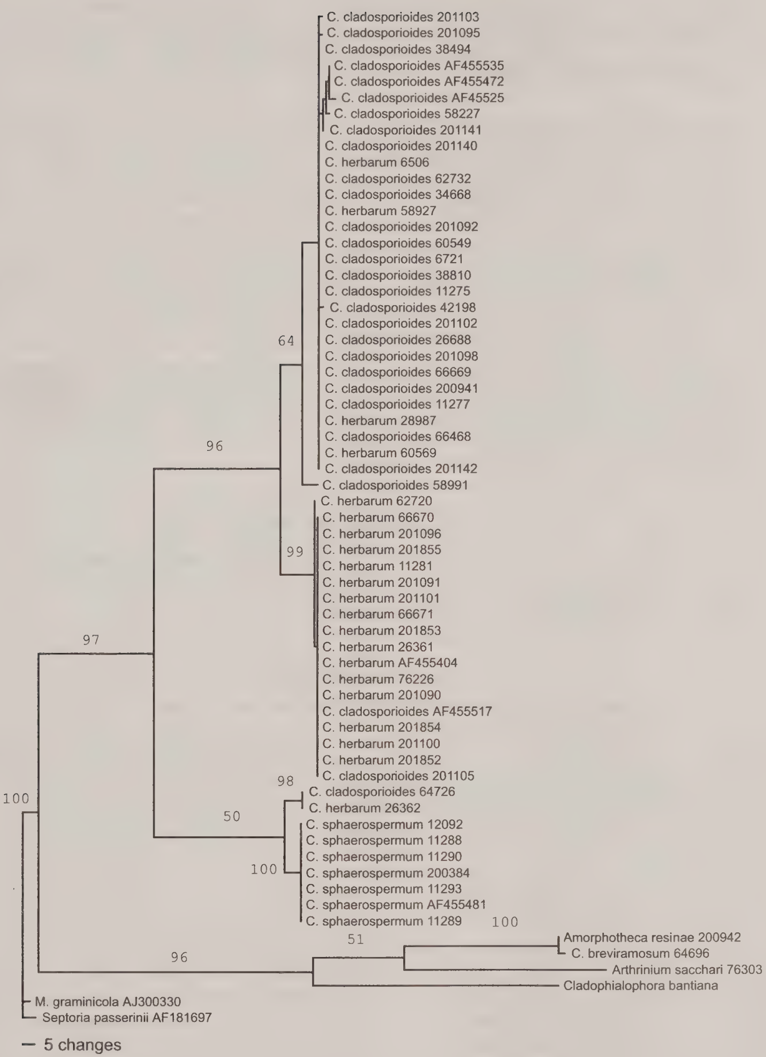
C. cladosporioides 201103
C. cladosporioides 201095
C. cladosporioides 38494
C. cladosporioides AF455535
C. cladosporioides AF455472
C. cladosporioides AF45525
C. cladosporioides 58227
C. cladosporioides 201141
C. cladosporioides 201140
C. herbarum 6506
C. cladosporioides 62732
C. cladosporioides 34668
C. herbarum 58927
C. cladosporioides 201092
C. cladosporioides 60549
C. cladosporioides 6721
C. cladosporioides 38810
C. cladosporioides 11275
C. cladosporioides 42198
C. cladosporioides 201102
64
C. cladosporioides 26688
C. cladosporioides 201098
C. cladosporioides 66669
C. cladosporioides 200941
C. cladosporioides 11277
C. herbarum 28987
C. cladosporioides 66468
96
C. herbarum 60569
C. cladosporioides 201142
C. cladosporioides 58991
C. herbarum 62720
C. herbarum 66670
C. herbarum 201096
99
C. herbarum 201855
C. herbarum 11281
C. herbarum 201091
C. herbarum 201101
C. herbarum 66671
97
C. herbarum 201853
C. herbarum 26361
C. herbarum AF455404
C. herbarum 76226
C. herbarum 201090
C. cladosporioides AF455517
C. herbarum 201854
C. herbarum 201100
C. herbarum 201852
C. cladosporioides 201105
98
100
C. cladosporioides 64726
50
C. herbarum 26362
C. sphaerospermum 12092
C. sphaerospermum 11288
C. sphaerospermum 11290
100
C. sphaerospermum 200384
C. sphaerospermum 11293
C. sphaerospermum AF455481
C. sphaerospermum 11289
100
51
Amorphotheca resinae 200942
96
C. breviramosum 64696
Arthrinium sacchari 76303
Cladophialophora bantiana
M. graminicola AJ300330
Septoria passerinii AF181697
5 changes

Fig. 3. Most parsimonious tree inferred with PAUP on the dataset of ITS sequences of rDNA of strains of the three airborne *Cladosporium* species. Maximum parsimony tree was constructed with the data set of 63 ITS sequences including nine sequences from GenBank. GenBank accession numbers for the sequences are given after the species name except *Cladophialophora bantiana. M. graminicola* was chosen as outgroup. The 62 ITS sequences were the ingroup. Numbers after species names are ATCC strain numbers. The number shown at each node is the Bootstrap value at 1000 replicates. Bootstrap values less than 50 percent are not shown.

morphology is highly problematic as the above situations illustrate. Discovery of analogous misidentifications is commonplace whenever large numbers of strains are closely examined by molecular-genetic methods (e.g. Kuhls et al. 1997).

By utilizing molecular data concurrent with information regarding conidial shapes and sizes, it was concluded that the *Cladosporium* strains could easily be differentiated at the species level. Employment of molecular and classical methods proved to be essential toward resolution of identification issues where morphological or cultural characters alone seemed insufficient. Interestingly, it would appear that the most reliable morphology-based method to differentiate these three species is by comparing the sizes of their conidia. As demonstrated in the phylogenetic trees and sequence alignments, *C. herbarum* and *C. cladosporioides* are more closely related to each other than *C. sphaerospermum* is to either one of them. The molecular data also demonstrated that strains of the three species collected over a broad range of area manifested very small nucleotide sequence variations.

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Literature cited

Al-Doory Y. 1984. Airborne fungi. In: Mould Allergy, ed. by Al-Doory, Y, Domson, JF Lea & Fibiger, Philadelphia, USA. pp. 27-40.

Braun U, Crous PW, Dugan FM, Groenewald JA, deHoog GS. 2003. Phylogeny and taxonomy of *Cladosporium*-like hyphomycetes, including *Davidiella* gen. nov., the teleomorphs of *Cladosporium s. str*. Mycol. Progress **2**:3-18.

Cenis JL. 1992. Rapid extraction of fungal DNA for PCR amplification. Nucleic Acids Res. **20**:2380.

David ND, Wagener E, Dalby DK, Morgan-Jones G, Diener UL. 1975. Toxigenic fungi in food. Appl. Microbiol. **30**:159-161.

David JC. 1997. A contribution to the systematics of *Cladosporium*. Revision of the fungi previously referred to *Heterosporium*. Mycol. Papers **172**:1-157.

de Hoog GS, Guarro J, Gené J, Figueras MJ. 2000. Atlas of Clinical Fungi, 2nd ed. Centraalbureau voor Schimmelcultures, Utrecht and Universitat Rovirai Virgili, Reus, Spain.

de Vries, GA. 1952. Contribution to the knowledge of the genus *Cladosporium* Link es Fr. Baar Uitgeverij &Drukkerij Hollandia.

Domsch KH, Gams W, Anderson T-H. 1980. Compendium of Soil Fungi, Vols. 1 & 2, Academic Press, London, UK.

Dugan FM, Roberts RG. 1994. Morphological and reproductive aspects of *Cladosporium macrocarpum* and C. *herbarum* from Bing Cherry fruits. Mycotaxon **52**:513-522.

Gardes M, Bruns TD. 1993. ITS primers with enhanced specificity for basidiomycetes – application to the identification of mycorrhizae and rusts. Mol. Ecol. **2**:113-118.

Georgiev OI, Nikolaev N, Hadjiolov AA, Skryabin S, Zakharyev VM, Bayev AA. 1981. The structure of the yeast ribosomal RNA genes. 4. Complete sequence of the 25S rRNA gene from *Saccharomyces cerevisiae*. Nucleic Acids Res. **9**:6953-6958.

Ho MHM, Castaneda RF, Dugan FM, Jong SC. 1999. *Cladosporium* and *Cladophialophora* in culture: Description and an expanded key Mycotaxon. **72**:115-157.

Horner WE, Helbling A, Salvaggio JE, Lehrer SB. 1995. Fungal allergens Clinical Microbiology reviews pp. 161-179.

Kuhls K, Samuels GJ, Meyer W, Kubicek CP, Börner T. 1997. Revision of *Trichoderma* sect. *Longibrachiatum* including related teleomorphs based on analysis of ribosomal DNA internal transcribed spacer sequences. Mycologia. **89**: 442-460.

Mullins J. 2001. Microorganisms in outdoor air, In: Microorganisms in Home and Indoor Work Environments: Diversity, Health Impacts, Investigation and Control, ed. by B. Flannigan, R.A. Samson and J.D. Miller. Taylor & Francis, London, UK. pp. 3- 16.

O'Donnell K. 1993. *Fusarium* and its near relatives. In: The fungal holomorph: mitotic, meiotic and pleomorphic speciation in fungal systematics, ed. by D. R. Reynolds and J. W. Taylor. CAB International, Wallingford, UK. pp. 225-233.

Samson RA, Hoekstra ES, Frisvad JC, Filtenborg O. 2000. Introduction to Food- and Airborne Fungi, 6th ed. Centraalbureau voor Schimmelcultures, Utrecht. p. 389

Shelton GB, Kirkland KH, Flanders WD, Morris GK. 2002. Profiles of airborne fungi in buildings and outdoor environments in the United States. Applied and Environmental Microbiology. **68**:1743-1753.

Wirsel SGR, Runge-Frobose C, Ahren DG, Kemen E, Oliver RP, Mendgen KW. 2002. Four or more species of *Cladosporium* sympatrically colonize *Phragmites australis*. Fungal Genetics and Biology **35**:99-113.

Swofford DL. 2000. PAUP: Phylogenetic analysis using parsimony, Version 4.0b4a. Sinauer Associates, Sunderland, MA, USA.

Tarlo SM, Fradkin A, Tobin RS. 1988. Skin testing with extracts of fungal species derived from the homes of allergy clinic patients in Toronto, Canada Clin. Allergy. **18**:45-52.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. 1997. The CLUSTALX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. Nucleic Acids Res. **25**:4876-4882.

Vilgalys R, Gonzalez D. 1990. Organization of ribosomal DNA in the basidiomycete *Thanatephorus praticola*. Curr. Genet. **18**:277-280.

White TJ, Bruns T, Lee S, Taylor JW. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. Pp 315-322 In: PCR Protocols: A Guide to Methods and Applications, ed. by Innis, MA, Gelfand, DH, Sninsky, JJ, White, TJ. Academic Press, Inc., NY.

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The genus *Astraeus* in Thailand

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Abstract—A new species of *Astraeus, A. odoratus,* is described from Thailand. *Astraeus odoratus* differs from *A. hygrometricus* in its strong odour when fresh, smooth outer peridium and globose spores with, long, narrow, coalescent, less densely arranged spines.

Key words—Gasteromycete, ectomycorrhizal fungi, taxonomy, ecology

Introduction

Astraeus is one of the most common gasteromycete genera in temperate and tropical ecosystems (Lloyd 1902). It is recognised in the field by the exoperidium splitting radially into segments to form a star-like pattern at maturity and by a strongly hygroscopic nature (Miller & Miller 1988). Morgan (1889) was the first to recognise *Astraeus* as a distinct genus with *A. hygrometricus* (Pers.) Morgan as the type and only species. However, this species was considered to belong to the genus *Geastrum* by many subsequent authors (e.g. Coker & Couch 1928, as *Geaster*). The genus *Astraeus* was based on the following characters; 1) no defined peristome, 2) no columella, 3) spores larger than those of any species of *Geastrum,* and 4) long, much branched, capillitial hyphae. Currently, two species are recognised in the genus, *Astraeus hygrometricus* (Pers.) Morgan, and *Astraeus pteridis* (Shear) Zeller, which differs particularly from the first in its considerably larger basidiomes. It has been reported that *Astraeus* forms ectomycorrhizal associations with several host tree species including *Pseudotsuga*, *Alnus*, *Eucalyptus* and *Castanea*

(Trappe 1967, Molina 1979, Malajczuk et al. 1982, Nouhra & Toledo 1998). *Astraeus* has been reported mainly from North America, Europe, Australia and Africa (Coker & Couch 1928, Cunningham 1944, Dring 1964) with fewer reports from Asia. This may be a reflection of the lack of collectors, although where studies have been carried out, the genus appears to be widespread (Teng 1996). Within Thailand, *Astraeus* is predominantly found in dry lowland dipterocarp forests particularly in the North and North Eastern parts of the country. It is considered to be a culinary delicacy and has a high market value. The lack of a current revision of Thai *Astraeus* species, coupled with their ability to form ectomycorrhizal associations and their importance as a source of food for local people, initiated the present study.

Materials and Methods

Astraeus basidiomes were collected during the rainy season, (May-August) 2001 and 2002, from localities in Thailand. Sources of 26 collections examined are given in Table 1. Conventional methods were used to study the basidiomes and characteristics including thickness of the peridium, glebal colour and features of external peridium whether smooth or encrusted with soil particles were recorded. Basidiospores mounted in Melzer's reagent (Largent et al. 1977) were examined and photographed by light microscopy. Spore size was determined by measuring the diameter of at least twenty spores and calculating their size ranges. Any ornamentation present was recorded and later critically analysed using scanning electron microscopy (SEM). Samples were air-dried and sputter-coated with gold and examined with a JEOL JSM-840 scanning electron microscope. The studies of fresh collections were supplemented with the examination of a selection of material of *A. hygrometricus* from the herbaria E and K (Tables 2 & 3).

Results

Basidiomes of 26 collections were examined (Fig.1). These varied in size (unexpanded specimens ranged from 18.5-39.6 mm. in diameter), shape (ranged from globose to depressed globose), colouring (ranged from dingy white to buff) and surface of the exoperidium (ranged from smooth to encrusted with soil debris). Basidiospores from all collections were studied and although varying in size, in other aspects they appeared very similar under the light microscope (Fig.2). Although examination of spores by light microscopy demonstrated that the basidiospores from the specimens were ornamented with well-developed spines, more detailed examination with SEM has enabled the collections to be divided into two distinct entities

Table 1. Specimens collected from different localities in Thailand during the present study.

No.	Code	Source
1	ASTO_01	Ban Nongpan, Dongkanyai, Yasothon province
2	ASTO_02	Ban Dongkanyai, Yasothon province
3	ASTO_03	Kudchum District, Yasothon Province
4	ASTO_04	Ban Dutoong, Muang District, Yasothon Province
5	ASTO_05	Ban Nampho, Muang District, Yasothon Province
6	ASTO_06	Ban Dutoong, Muang District, Yasothon Province
7	ASTO_07	Ban Dutoong, Muang District, Yasothon Province
8	ASTO_08	Ban Khuangkam, Muang District, Yasothon Province
9	ASTO_09	Ban Warisawadh, Pranomprai District, Roi Et Province
10	ASTO_10	Ban Nampho, Muang District, Yasothon Province
11	ASTO_11	Ban Panus, Pranomprai District, Roi Et Province
12	ASTO_12	Ban Tayiam, Muang District, Yasothon Province
13	ASTO_13	Ban Nongpan, Kamkhuankaew District, Yasothon Province
14	ASTO_14	Ban Warisawadh, Pranomprai District, Roi Et Province
15	ASTO_15	Ban Maesart, Muang District, Chiang Rai Province
16	ASTO_16	Ban Nampho, Muang District, Yasothon Province
17	ASTO_17	Ban Kammuang, Yasothon Province
18	ASTO_18	Ban Tayiam, Muang District, Yasothon Province
19	ASTO_19	Ban Bongkheelek, Khemaraj District, Ubolrajathani Province
20	ASTO_20	Ban Maesart, Muang District, Chiang Rai Province
21	ASTO_21	Ban Dutoong, Muang District, Yasothon Province
22	ASTO_22	Ban Kamnamsarng, Muang District, Yasothon Province
23	ASTO_27	Ban Srisuk, Pranomprai District, Roi Et Province
24	ASTO_28	Huathapan District, Amnajcharoen Province
25	ASTO_29	Ban Srisuk, Pranomprai District, Roi Et Province
26	ASTO_30	Ban Phosri, Muang District, Yasothon Province

referred to as spore type 1 and spore type 2 (Fig.3). In the two groups spore size varied from 8.75-15.2 μm and 7.5-15.2 μm respectively (Table 4). Type 1 was characterized by very dense ornamentation consisting of rounded, narrow, tapered, occasionally coalesced, spines 0.90-1.45 μm long, whilst Type 2 was characterized by moderately dense, rounded, long, narrower, coalesced, spines, 1.04-1.66 μm long. Our observations based on basidiome and spore morphology, show that Thai collections of *Astraeus* can be separated into 2 distinct groups. One can be recognised as *A. hygrometricus* but the other is an undescribed species. Full descriptions of the two entities are given below.

Table 2. Material examined from Royal Botanic Garden at Edinburgh (Scotland)

No	Source	Exsiccata/Collector	Date
1	Florence, Italy	F. Amatt	1821
2	Prenczow, Czechoslovakia	A. Kmet	July 1891
3	Hermosa, Southern Colorado, USA	C.F. Baker 13	29/03/1899
4	Ventuna, Greece	M. Willson 167	Nov 1908
5	Western China	E.E.Maire 1238	July 1913
6	Nagasaki, Japan	No. 574	Apr 1962
7	Zambia (Northern Rhodesia)	A. Angus M2615	08/04/64
8	Jackson Co., Michigan, USA	R. Watling 648/875A	18/04/65
9	Upper Peninsular Michigan, USA	R. Watling 709/1137A	06/08/65
10	Upper Peninsular Michigan, USA	R. Watling 900/A2067	06/08/65
11	Whitefish Pr., Michigan, USA	R. Watling 874/A2032	27/12/65
12	Lower Peninsular Michigan, USA	R. Watling 6982	04/10/69
13	Velem, Hungary	M. Seaward Wat. 26311	04/08/83
14	Lucca Prov. North East of Barga; 1/3 way to Renáio, Italy	L. Cram & M.Potts Coppins 12452	30/04/85
15	Yifeng temple, Lijiang Co., Yunnan, China	D.F.Chamberlain	May 1985
16	Near Dali to Zhongdian, Yunnan, China	R. McBeath	09/06/94
17	Sichuan Rd. from Wengsui to Xang chen, China	R. McBeath	Oct 1994
18	Tsukuba, Japan	C. Walker Wat. 26075	14/11/94
19	Inashik-gun, Ibaraki, Japan	C.Walker Wat. 26076	14/11/94
20	Spain	D.Fieldhouse Wat. 9159	Mar 1955
21	Aiken, South Carolina, USA	H.W.Ravenel 471, Fungi American Exsiccati	(1878-1887)
22	England	M.C. Cooke Fungi Britannici Exsiccati	N/A
23	France	Herb. M.C. Cooke (1885)	N/A
24	A- Brunel, France	Herb. M.C. Cooke (1885)	N/A
25	Paris	N/A	N/A
26	France	Mougeot & Nestler 1193 Crypt.Vogeso-Rhenanae Stirps	N/A
27	Paris	N/A	N/A
28	N/A	Herb. Hookerianum (1867)	N/A
29	West Australia	A. Morrison	N/A

Table 3. Material examined from Royal Botanic Garden at Kew

No.	Herb. No.	Source	Collector	Date
1	K(M) 104975	Mataru district, Sri Lanka	J.Wambeek, H. & H. E. Wanntorp	07/01/74
2	K(M) 104973	West Bengal, India	Sri Sutini Ray	1974
3	K(M) 104971	Los Limones, Honduras	M.H.Ivory	29/09/76
4	K(M) 104968	Zambia	G.D.Pearce	01/02/77
5	K(M) 104969	Mollans sur Ouveze, France	E.A.Ellis	Aug 1977
6	K(M) 104966	Honshu, Japan	D.N.Pegler	06/09/83
7	K(M) 104970	Tenerife, Canary Island	C.L.Champion	16/04/84
8	K(M) 104967	Uzbekistan	B.Mathew & C.D.Brickell	19/04/84
9	K(M) 29029	Devon, England	P.J. Roberts	Oct 1986
10	K(M) 26954	Sao Paulo, Brazil	D.N.Pegler, K.Hjortstam & L.Ryvarden	17/01/87
11	K(M) 18466	Kent, England	J. Weightman	20/10/91
12	K(M) 19550	Mexico	W.C.Weightman	10/03/92
13	K(M) 50616	Gard, France	B. W. Brown	23/03/97
14	K(M) 81503	Cornwall, England	D. Farley	09/11/2000

1. *Astraeus hygrometricus* (Pers.) Morgan

Basidiomes: globose or depressed globose, subepigeous, sessile 18.7-29.7 mm. in diam., splitting to become star-shaped, covered with thin, white mycelial layer when unexpanded which tears away at maturity, often partly encrusted with soil debris; with slight odour when fresh.

Outer peridium: whitish, thick, composed of several layers (≥1 mm.when dry), rigid, surface granulate, at maturity splitting into 5-12 acute rays which expand or recurve when moist and roll inwards again on drying; inner layer whitish becoming smoke-grey, cigar-brown or sepia, thick, extensively longitudinally cracked in mature specimens.

Endoperidum: sessile, subglobose, 13-24 mm. in diam., whitish to smoke-grey, opening by an apical, irregular mouth lacking defined peristome.

Gleba: pure white in early stages, purplish chestnut when mature, columella none; capillitium of long, branched, interwoven, hyaline, slightly encrusted, aseptate threads, 2.5-7.5 μm in diam.; wall thin or thickened with a narrow, sometimes discontinuous lumen; clamp-connections present.

Basidiospores: globose, ranging from 8.75-15.2 μm diam. including ornamentation, purplish chestnut, very densely ornamented with rounded, narrow, tapered, occasionally coalescent, spines 0.90-1.45 μm long.

Habitat: sandy or lateritic soil in dry lowland dipterocarp forests, fruiting frequently in rainy season between May-August.

Distribution: North and North Eastern areas of Thailand

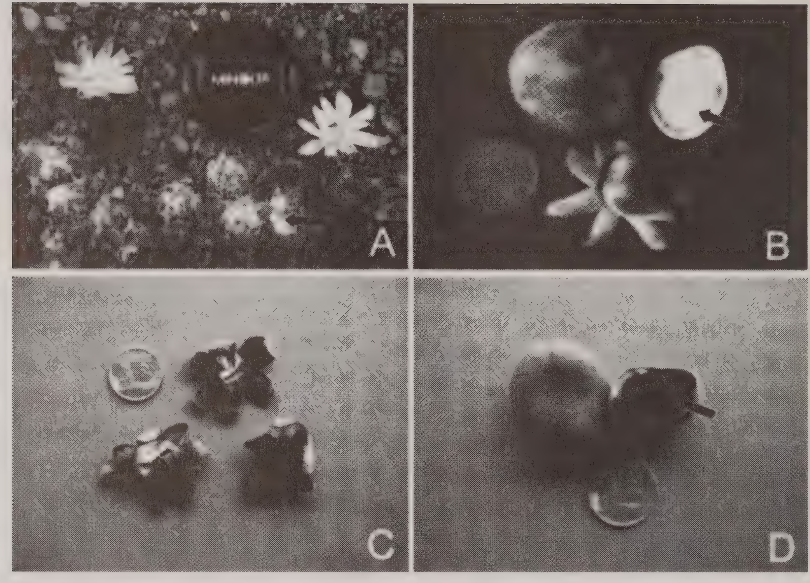

Fig. 1 Basidiomes of *Astraeus hygrometricus* and *A. odoratus*. A: *A. hygrometricus*; unexpanded specimens develop under the ground (arrow) and become strongly hygroscopic when mature. B: pure white gleba (arrow) at early stage of *A. hygrometricus*. (Thai coin *ca*.2.3 cm. in diam.) C: *A. odoratus* at maturity (Thai coin *ca*.2.0 cm. in diam.). D: unexpanded specimens of *A. odoratus* showing purplish chestnut gleba (arrow) and little soil debris on surface (Thai coin *ca*.2.0 cm. in diam.).

2. *Astraeus odoratus* C. Phosri, R. Watling, M. P. Martín, & A. J. S. Whalley, *sp. nov.*

Carpophorum: Subhypogaeum, ≤ 65 mm. diam., globosum ad depresso-globosum, sublaeve, cum applicitis, baso-rhizomorphis circumcinctum. **Exoperidium:** siccum solum crassum ≤ 1 mm., externe bubalinum vel brunneum, interne bubalinum ad olivaceo-brunneum vel fusco-brunneum, stellato-scissorum; **Endoperidium:** subglobosum, albidum vel griseum c. 13-24 mm. diam. **Gleba:** matura purpureo-brunnea, compacta. **Odor:** validus gratus. **Sporae:** globosae 7.5-15.2 μm. diam., brunneae, verrucosae cum verruculis conicus, solis vel aggregatis.1.04-1.66 μm. altis. **Fibulatae:** rarae.

Holotypus: Pranomprai district, Roi Et province, Thailand, 6 June 2002, E159386.

Basidiomes: globose or depressed globose at first, submerged, sessile, becoming superficial, expanding to become ≤ 65 mm. in diam., hard, smooth surface with few soil adhering particles, finally splitting to become star-shaped; basal mycelium consisting of brown vinaceous or bay rhizomorphs; in fresh condition specimens emitting strong odour of moist soil.

Outer peridium: buff or snuff brown, consisting of several layers, ≤1 mm. when dry, at maturity splitting into 3-9 broad rays which expand stellately when wet and become involute on drying; inner layer varying from buff to brownish, sepia, smoke-grey, hazel, olivaceous or fuscous black, thin, scaly cracked, occasionally smooth.

Endoperidium: sessile, subglobose, ca. 13-25 mm. broad, buff to brownish or violaceous black, opening by irregular apical mouth, lacking defined peristome.

Gleba: purplish chestnut occasionally cigar-brown, date-brown, brown vinaceous or violaceous black; columella none; capillitium of long, branched, interwoven, hyaline, aseptate, slightly encrusted, threads 2.5-6.25 μm in diam.; wall thin with a narrow continuous lumen; clamp-connections occasional, usually absent

Basidospores: globose, 7.5-15.2 μm in diam. including ornamentation, purplish chestnut occasionally cigar- or date-brown, brown vinaceous or violaceous black, ornamented with moderately dense, rounded, long, narrow, coalescent spines, 1.04-1.66 μm long.

Habitat: Sandy or lateritic soil in dry lowland dipterocarp forests, fruiting during rainy season between May-June.

Distribution: North and North Eastern areas of Thailand.

Table 4. Basidiospore characteristics of Thai *Astraeus* collections

Type	Specimen code	Spore diam. (μm)	Mean spore diam. (μm)
1	ASTO_02	8.75-12.50	10.63±1.11
	ASTO_03	8.75-12.50	10.56±1.37
	ASTO_04	8.75-12.50	10.63±1.31
	ASTO_05	8.75-13.30	11.08±1.47
	ASTO_07	9.50-15.20	11.50±1.69
	ASTO_15	9.50-13.30	10.93±1.21
	ASTO_27	9.50-13.30	11.12±0.93
	ASTO_29	9.50-13.30	10.64±1.29
2	ASTO_01	7.50-12.50	10.94±1.21
	ASTO_06	9.50-13.30	11.28±1.20
	ASTO_08	9.50-13.30	10.64±1.29
	ASTO_09	9.50-15.20	12.26±1.44
	ASTO_10	9.50-13.30	11.78±1.17
	ASTO_11	9.50-13.30	11.12±1.12
	ASTO_12	9.50-13.30	11.69±1.66
	ASTO_13	9.50-13.30	10.93±1.05
	ASTO_14	11.40-15.20	12.54±1.14
	ASTO_16	7.60-13.30	10.55±1.44
	ASTO_17	9.50-15.20	11.12±1.54
	ASTO_18	9.50-15.20	11.21±1.62
	ASTO_19	9.50-13.30	11.40±1.51
	ASTO_20	9.50-13.30	10.93±1.21
	ASTO_21	7.60-11.40	10.17±1.12
	ASTO_22	9.50-13.30	11.31±1.30
	ASTO_28	9.50-13.30	10.45±1.31
	ASTO_30	7.60-13.30	10.64±1.43

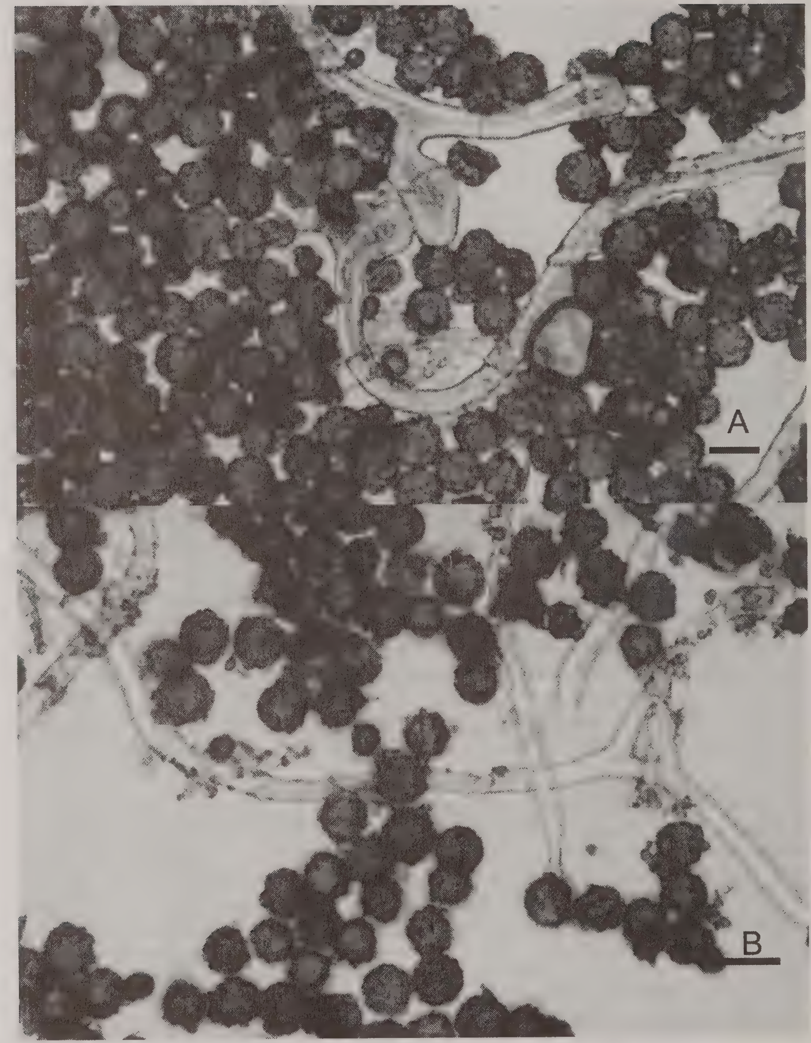

Fig. 2 Light microscopy of mature basidiospores. A: *Astraeus hygrometricus*. B: *Astraeus odoratus*. Scale bars = 10 μm.

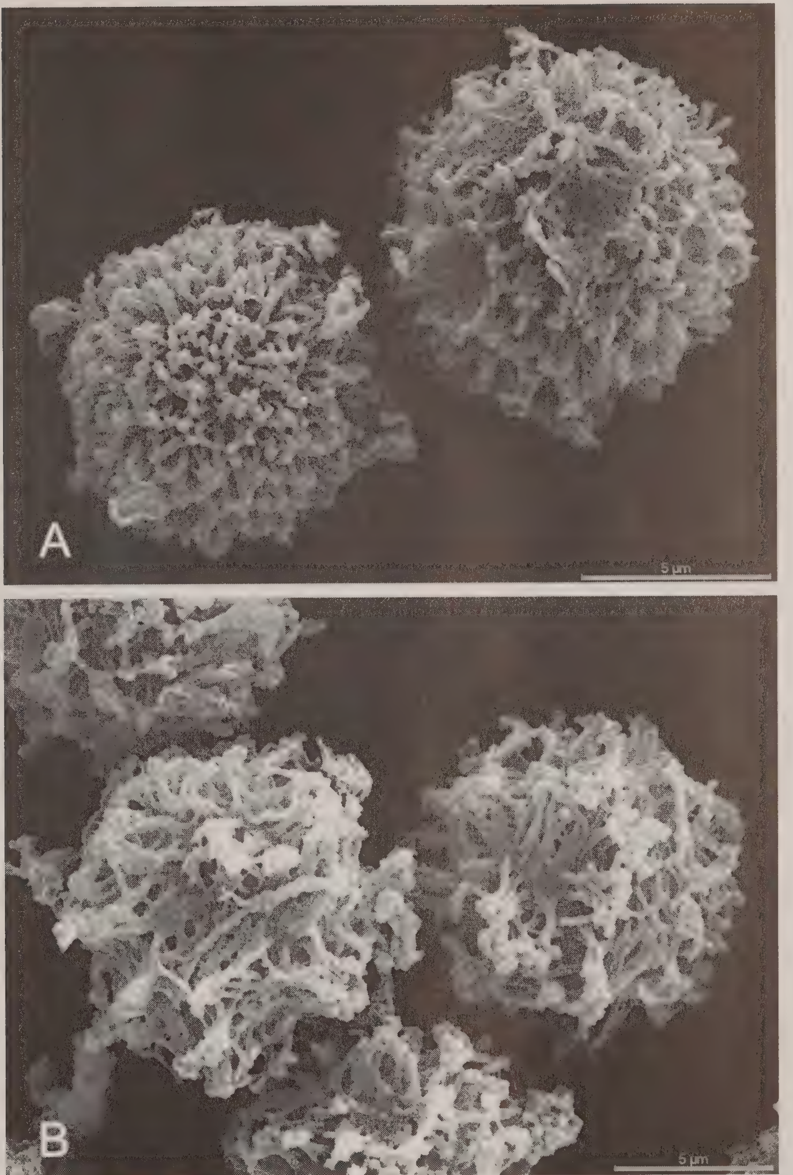

Fig. 3 Scanning electron micrograph of mature basidiospores from selected *Astraeus* isolates displaying different spine morphology A: very dense with rounded, narrow, tapered spines, occasionally coalesced of *Astraeus hygrometricus* .B: less dense, long, narrow, coalesced spines of *Astraeus odoratus*.

Table 5. Structural differences between *A. hygrometricus* and *A. odoratus*

Feature	*A. hygrometricus*	*A. odoratus*
Outer peridium	Granulate	Smooth with few soil particles
Number of rays	5-12 acute rays	3-9 broad rays
Fresh odour	Slight	Strongly reminiscent of moist soil
Spore size	8.75-15.2	7.5-15.2
Fruiting season	May-August	May-June

Discussion

The first description of *A. hygrometricus* was made by Persoon (1801 as *Geastrum*) and it was confirmed as a distinct taxon by Morgan (1889) with further descriptions by Lloyd (1902), Coker & Couch (1928) and Cunningham (1944). It is apparently worldwide in distribution and usually occurs in sandy soil in coniferous or mixed woods as previously reported from North America, Argentina and Mexico, Europe, Australia, China and India (Lloyd 1902, Cunningham 1944, Nouhra & Toledo 1998). All authorities stress the strongly hygroscopic traits and the globose, densely spiny spores ranging from 7.5-12.0 μm in diameter. However, in the current study, the spore size was found to be greater than generally given for this species, varying between 8.75-15.20 μm. in diameter. It was also noticed that the Thai specimens have a slight odour when fresh. The newly proposed taxon, *A. odoratus*, can be distinguished from *A. hygrometricus* by the strong odour when fresh, smooth surface with few adhering soil particles and the number of rays. In addition, this species occurs frequently during May-June whereas *A. hygrometricus* can be found in Thailand over a more prolonged period from May-August (Table 5).

Kope & Fortin (1990) suggested that differences in basidiospore types revealed under SEM could be used to segregate *Pisolithus arhizus* (Pers.) Rausch. into biological species. Although the basidiospores of the newly proposed taxon were identical in morphology with those of *A. hygrometricus* when viewed under the light microscope, observations using SEM showed that basidiospores of *A. odoratus* can be distinguished from those of *A. hygrometricus*. The spore ornamentation of the former is characterized by moderately dense, longer, narrower, coalescent spines.

There is still the possibility that *A. hygrometricus* as currently understood is a complex consisting of species and several approaches similar to those used for analysing *Pisolithus* may allow separation of further distinct taxa within the *A. hygrometricus* group. Thus *A. hygrometricus* var. *koreanus* Stanek, described from a mountainous area near Chon-Dzin, Korea and differing in its smaller size and pale colour may prove to be synonymous.

The differences, apart from size between *A. hygrometricus* and *A. pteridis* (= *Geastrum hygrometricum* var. *giganteus* Lloyd) the only other species in the genus need to be quantified. Further, much work needs to be done before the number and separation of the species are completely understood.

Acknowledgements

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References

Coker WC, Couch JN. 1928. *The Gasteromycetes of the Eastern United States and Canada*. University of North Carolina Press, Chapel Hill. 201 p.

Cunningham GH. 1944. *Gasteromycetes of Australia and New Zealand*. Dunedin. 236 p.

Dring DM. 1964. Gasteromycetes of West Tropical Africa. *Mycological Papers* **98** (**15**) : 1-60.

Kope HH, Fortin JA, 1990. Germination and comparative morphology of basidiospores of *Pisolithus arhizus*. *Mycologia* **82**: 350-357.

Largent DL, Johnson D, Watling R. 1977. *How to Identify Mushrooms to Genus III: Microscopic Features*. Mad River Press, Eureka. 148 p.

Lloyd CG. 1902. *The Geastrae*. Cincinnati. 43 p.

Malajczuk N, Molina R, Trappe JM. 1982. Ectomycorrhiza formation in *Eucalyptus* I. Pure culture synthesis, Host specificity and Mycorrhizal compatibility with *Pinus radiata*. *New Phytologist* **91**: 467-482.

Miller OK, Miller SL. 1988. *Gasteromycetes*. Mad River Press, Eureka. 157 p.

Molina R. 1979. Pure culture synthesis and host specificity of red alder mycorrhizae. *Canadian Journal of Botany* **57**: 1223-1228.

Morgan AP. 1889. North American Fungi: The Gastromycetes. *Journal Cincinnati Society Natural History* **12**: 8-22.

Nouhra ER, Dominguez De Toledo L. 1998. The first record of *Astraeus hygrometricus* from Argentina. *Mycologist* **12(3)**: 112-113.

Persoon CH. 1801. *Synopsis methodica fungorum*. göttingen. pp. 129-156, 241-246.

Teng SC. 1996. Fungi of China, ed. R. P. Korf. *Mycotaxon*. New York. 586 p.

Trappe JM. 1967 Pure culture synthesis of Douglas-Fir mycorrhizae with species of *Hebeloma, Suillus, Rhizopogon* and *Astraeus*. *Forest Sciences* **13(2)**:121-130.

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Taxonomic reconsideration of *Epicoccum nigrum* and *Phoma epicoccina* based on DNA sequences and morphological observations

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Abstract—The species *Epicoccum nigrum* and *Phoma epicoccina* were compared morphologically and molecularly. Some isolates originally identified as *E. nigrum* developed a "*Phoma*-like" pycnidial state. A phylogenetic tree derived from the sequences of the ITS region of a group of isolates from both species and other *Phoma* related species revealed that all the strains form a monophyletic group, and no further segregation was found among the isolates analyzed. Based on this data, together with morphological observations, we propose formally the synonymization of both species.

Key Words—ITS, phylogeny, rDNA, synanamorph, taxonomy

Introduction

Epicoccum nigrum Link is a dematiaceous hyphomycete characterized by pulvinate stromata, black sporodochia, which produce granular-verrucose conidia globose to pyriform (Schöl-Schwarz 1959). It is a very polymorphic fungus, showing large differences across isolates in a range of characters, including pigmentation, conidial size, presence of sectors in pure culture, secondary metabolite production and others. This large variability has been evidenced using diverse techniques available for the genotypic and phenotypic characterization of fungal strains (Arenal et al. 1999; 2002; Kilpatrick & Chilvers 1981). *E. nigrum* is a common saprophyte that can be isolated from a broad diversity of substrates (Arenal et al. 1999; Domsch et al. 1993; Ellis 1971).

Phoma epicoccina Punith., Tulloch & Leach was described from seeds of *Dactylis glomerata* (Punithalingam et al. 1972). It was characterized by the presence of an associated "*Epicoccum* state", morphologically indistinguishable from a typical *E. nigrum*. *Phoma*-like species are a wide spread coelomycetes (Boerema et al. 2004) and sometimes show hyphomycetous synanamorphs assigned to different genera (Grondona et al. 1997). *Phoma epicoccina* was included by Boerema (1997) within section Peyronaella (Goid. ex Togl.) Boerema, together with other *Phoma* species developing multicellular chlamydospores.

Previous molecular data, derived from the sequences of the ITS region of nine strains initially characterized as either *E. nigrum* or *P. epicoccina*, seggested that both were the same biological species (Arenal et al. 2000). However, the fact that no isolate of *E. nigrum* developed the *Phoma* state prevented us to reduce both species as synonyms. More recent morphological observations have revealed that some of the strains initially characterized as *E. nigrum* may, under some conditions, develop a *Phoma* state as well. Based on these observations, firstly reported in this study, and on the molecular data described above, wich are subjected to some reanalyses, we propose formally in this work the synonymization of both species.

Materials and Methods

The *P. epicoccina* and *E. nigrum* strains used in this study and the GenBank accession numbers of their ITS sequences are shown in Table 1.

Table 1. Strains of *Epicoccum nigrum* and *Phoma epicoccina* studied

Strain code*	**GenBank accession number**	**Geographic origin**	**Substrate**
EN22	AF149927	Spain	Fruiting body of *Resupinatus applicatus*
EN27	AF149928	Spain	Twigs of *Thymus mastichina*
EN33	AF149939	Ecuador	Leaves of undetermined bush
EN34	AF149930	Ecuador	Leaves of undetermined bush
EN5	AF149926	Colombia	Bark of *Vismia* sp.
PE20002	AF149931	United Kingdom	Seedlings of *Picea sitchensis*
PE20003	AF149932	United Kingdom	Seedlings of *Picea sitchensis*
PE20028	AF149933	United Kingdom	Emulsion paint of PVA
PE20044	AF149934	The Netherlands	Human toe nail

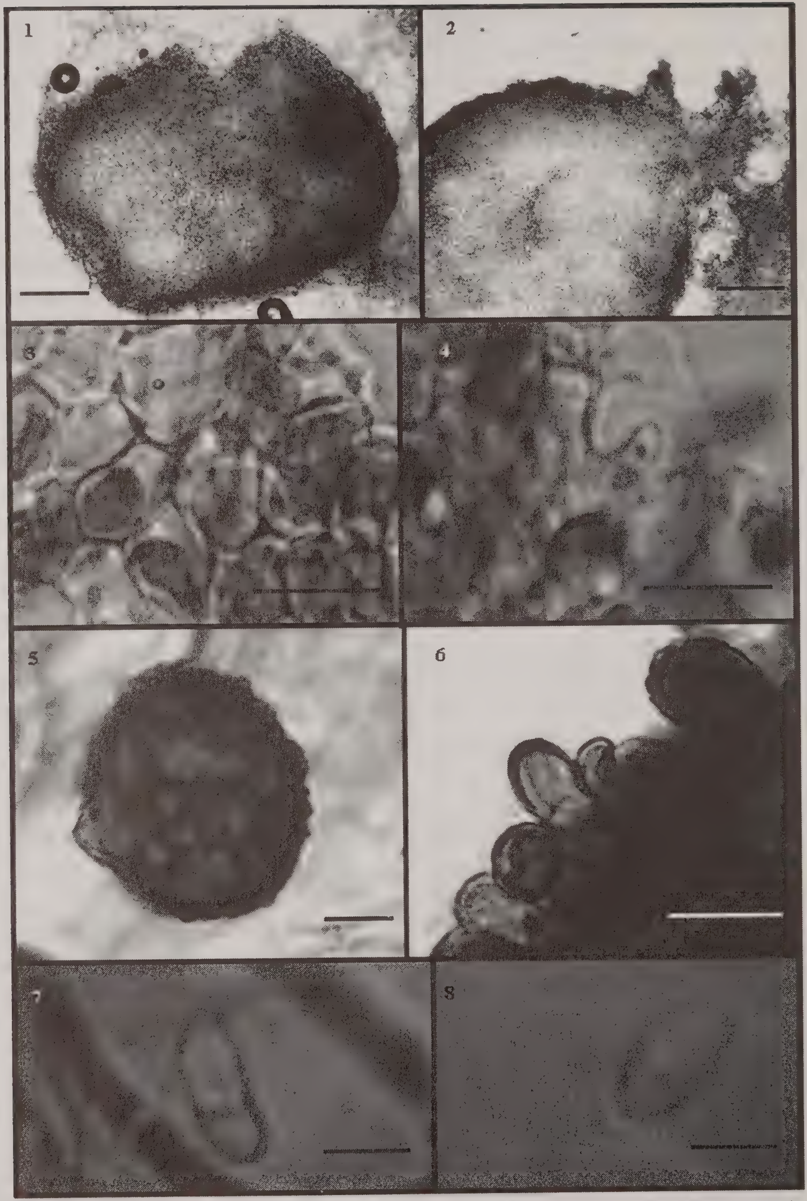
EN= *Epicoccum nigrum*. Strains isolated by the authors.
PE= *Phoma epicoccina*. Strains from the CECT (Colección Española de Cultivos Tipo, Valencia, Spain), replicated from cultures of the International Mycological Institute (Egham, Surrey, UK). PE20002 and PE20003 are monosporic isolates derived from the same parental strain, IMI276463; PE20028 and PE20044 are monosporic isolates from strains IMI178513 and IMI331914, respectively. All the strains are preserved in the collection of fungal cultures at CIBE-MSD.

All the isolates were grown at 22ºC under 12 hour day light/dark cycle, on potato dextrose agar (PDA). Two replicates of each *E. nigrum* strain were grown on the same culture media and temperature/humidity conditions, but with alternate cycles of 12 hour UV irradiation and darkness. After 14 days their morphological features were studied and, after sporulation, slides were prepared on lactophenol cotton blue and observed under a Leitz Diaplan microscope. Photographs were made with an Olympus DP-12 digital camera system incorporated to the Leitz microscope.

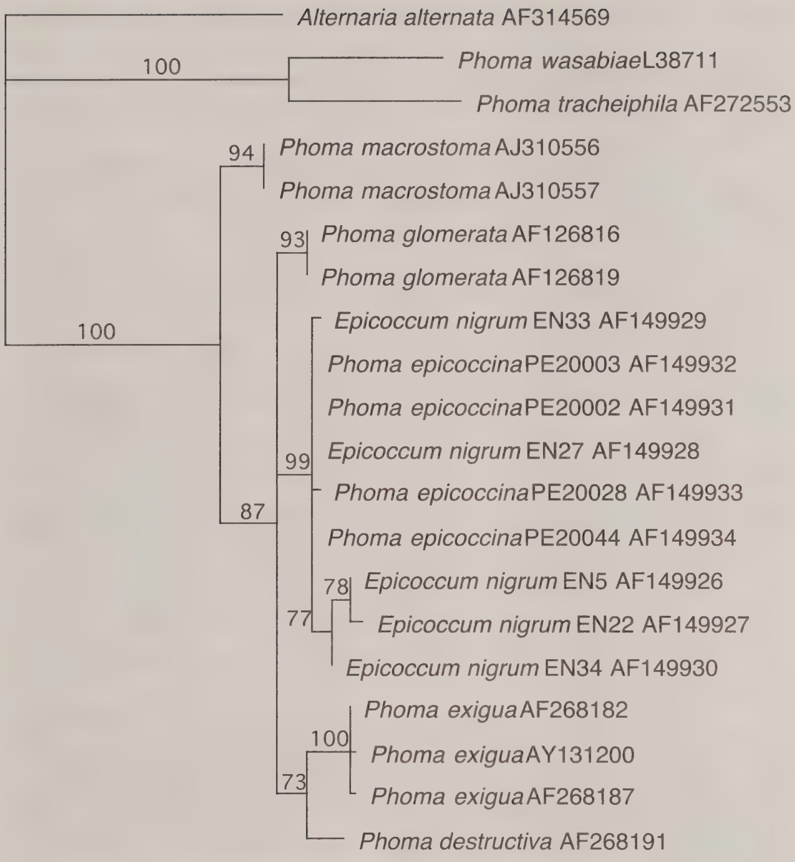
Phylogenetic analysis of the aligned sequences was performed by the maximum parsimony method using the heuristic search algorithm of the Phylogenetic Analysis Using Parsimony (PAUP 4.0) software (Swofford 1998). Heuristic search was performed with simple addition of sequences and TBR branch swapping, with MaxTrees set to 100. All characters were unordered and equally weighted, with gaps treated as missing data. The trees were rooted with the ITS sequence of *Alternaria alternata* (AF314569) as outgroup. The data were resampled with 1000 bootstrap replicates (Felsenstein 1985).

Taxonomy and Discussion

All the *E. nigrum* and *P. epicoccina* strains were sporulated after 14 days of incubation. All of the isolates showed the macroscopic phenotypic characteristics (mycelium growth and pigmentation) described for both species, being white to pinkish tints and velvety in *P. epicoccina* and yellow to orange, orange to red or pink in color, greenish-brown and woolly to cottony, in *E. nigrum*. The conidiogenesis and conidia showed the morphological features described for both species (Schöl-Schwarz 1959; Punithalingam et al. 1972). Three of the strains initially labeled as *E. nigrum* (EN5, EN33 and EN34), when grown under UV light, developed also a pycnidial *Phoma*-like state, together with the *Epicoccum* state. (Figs. 1-8). The same test had been previously carried out, but at that time these *Epicoccum* strains failed to produce any *Phoma* state at all (Arenal et al. 2000). There is not any obvious explanation for the different results obtained now, although it looks that most of the studies carried out before were done under a *Phoma* point of view. Thus, in former studies (Monte et al. 1990), monosporic cultures from *Epicoccum*-like conidia from *P. epicoccina* (PE isolates) were able to develop mycelium with pycnidia and *Phoma*-like conidia. However, little attention was given to the fact that the *Epicoccum*-like conidia from the PE isolates could originate *Phoma* states, since it was considered as obvious. All the *Epicoccum* states produced by *P. epicoccina* strains were indistinguishable from those produced by *E. nigrum* isolates, as described by Punithalingam et al. (1972), and all the *Phoma*-like states produced by the three *E. nigrum* isolates were indistinguishable from those produced by the *P. epicoccina* strains. The *Epicoccum* mature conidia were globose to pyriform, 10-45 μm in diameter, with reticulated surface, rough and verrucose to warty, and light to dark brown (Fig. 5).



Figs. 1-8. Figs. 1,2. Pycnidia produced by *Epicoccum nigrum* EN5 and *Phoma epicoccina* PE20003, respectively. Fig. 3. Pycnidial wall cells of EN5. Fig. 4. Inner pycnidial line of EN5. Fig. 5. Conidium produced by EN5. Fig. 6. Immature sporodochium in EN5. Figs. 7,8.Pycnidial conidia produced by EN5 and by PE20003, respectively. Bars 1,2= 100 μm; bars 3, 4, 6-8= 5 μm; bar 5= 10 μm.



Alternaria alternata AF314569
100
Phoma wasabiae L38711
Phoma tracheiphila AF272553
94
Phoma macrostoma AJ310556
Phoma macrostoma AJ310557
93
Phoma glomerata AF126816
Phoma glomerata AF126819
100
Epicoccum nigrum EN33 AF149929
Phoma epicoccina PE20003 AF149932
Phoma epicoccina PE20002 AF149931
Epicoccum nigrum EN27 AF149928
99
Phoma epicoccina PE20028 AF149933
87
Phoma epicoccina PE20044 AF149934
78
Epicoccum nigrum EN5 AF149926
77
Epicoccum nigrum EN22 AF149927
Epicoccum nigrum EN34 AF149930
Phoma exigua AF268182
100
Phoma exigua AY131200
73
Phoma exigua AF268187
Phoma destructiva AF268191

Fig. 9. Phylogenetic tree obtained by maximum parsimony method of *E. nigrum* and *Phoma* related species. The tree was rooted with *Alternaria alternata* as outgroup.

The conidia were always produced clustered in sporodochia, appearing in culture like black dots. The pycnidia produced by both *Epicoccum* and *Phoma* strains were scattered, globose to pyriform shaped, 90-150 μm in diameter, hyaline, reddish to light brown and ostiolate, sometimes with conspicuous neck (Figs. 1 and 2). The conidia produced in the inner line of the pycnidia were unicellular, 5-10 x 2-4 μm, hyaline and cylindrical to ellipsoid shaped (Figs. 7 and 8). To our knowledge, this is the first report of pycnidial development in isolates originally identified as *E. nigrum*.

As previously reported, the sequencing of the ITS region supports that *P. epicoccina* and *E. nigrum* could represent the same biological species (Arenal et al. 2000). The maximum nucleotide divergence found between isolates of both species collected from very different geographical locations was very low; 1.5% for the entire ITS region, 2.8% for the ITS1 and 3% for the whole region sequenced. Furthermore, two strains identified as *P. epicoccina* (PE20003, PE20044) and two others as *E. nigrum* (EN27, EN33) showed identical sequences.

The closest matches of these sequences found in GenBank were with sequences from other *Phoma* species (Arenal et al. 2000). Some of those ITS sequences were retrieved and aligned together with our *E. nigrum /P. epicoccina* strains, and the alignment was subjected to parsimony analyses. One of the most parsimonious trees derived from this analysis is shown in Fig. 9. The complete alignment was 517 characters, with 353 constant characters, 89 parsimony-informative positions and 75 parsimony-uninformative positions. The tree length was 236 steps, with CI = 0.846, HI = 0.136, RI = 0.853, and RC = 0.738. The phylogenetic analysis revealed that all the strains of *E. nigrum* and *P. epicoccina* fall into a monophyletic clade supported by high bootstrap values (99%). The strains labeled as *E. nigrum* or *P. epicoccina* appeared intermingled within this branch, without any further segregation. The only subgroup that was observed in this clade, which is supported by modest bootstrap (77%) contains three *E. nigrum* isolates, two of wich developed a *Phoma* state (EN5 and EN34) and one that did not (EN22). *Phoma glomerata*, *P. exigua* and *P. destructiva* appeared as the closest species to the *E. nigrum/P. epicoccina* cluster, all of them grouped together in a single clade with 87% bootstrap support.

In summary, we conclude that the molecular and morphological data presented in this work clearly evidence that *E. nigrum* and *P. epicoccina* are synonyms. Therefore, according the International Code of Botanical Nomenclature (Greuter et al. 2000), the name *E. nigrum* should be used to name all the isolates showing an *E. nigrum* state, regardless of the presence of a *Phoma* state.

Epicoccum nigrum Link, in *Mag. Ges. Naturf. Fr., Berl.* 7: 32. 1816
= *Epicoccum purpurascens* Ehrenb., in *Flora Berol.* 136. 1818
= *Epicoccum purpurascens* Ehrenb. ex Schlecht, in *Flora Berol.* 2: 136. 1824
= *Phoma epicoccina* Punith., Tulloch & Leach, in *Trans. Br. mycol. Soc.* 59 (2): 341. 1972

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References

Arenal F, Platas G, Martín J, Salazar O, Peláez F. 1999. Evaluation of different PCR-based DNA fingerprinting techniques for assessing the genetic variability of isolates of *Epicoccum nigrum*. J. Appl. Microbiol. 87: 898-906.

Arenal F, Platas G, Monte E, Peláez F. 2000. ITS sequencing support for *Epicoccum nigrum* and *Phoma epicoccina* being the same biological species. Mycol. Res. 104: 301-303.

Arenal F, Platas G, Martín J, Asensio FJ, Salazar O, Collado J, Vicente F, Basilio A, Ruibal, C, Royo I, De Pedro N, Peláez F. 2002. Comparison of genotypic and phenotypic techniques for assessing the variability of the fungus *Epicoccum nigrum*. J. Appl. Microbiol. 93: 36-45.

Boerema GH. 1997. Contributions towards a monograph of Phoma (Coelomycetes) – V. Subdivision of the genus in Sections. Mycotaxon 64: 321-333.

Boerema GH, de Gruyter J, Noordeloos ME, Hamers MEC. 2004. Phoma identification manual. Differentiation of specific and infraspecific taxa in culture. Wallingford, UK: CABI Publishing . 448 pp. (in press).

Domsch KH, Gams W, Anderson TH. 1993. Compendium of Soil Fungi. IHW-Verlag: Eching, Germany.

Ellis MB. 1971. Dematiaceous Hyphomycetes. Common W. Mycol. Inst. 608 pp. UK.

Felsenstein J. 1985. Confidence intervals on phylogenies: an approach using the bootstrap. Evolution 39:783-791.

Greuter W, McNeill J, Barrie FR, Burdet HM, Demoulin V, Filgueiras TS, Nicolson DH, Silva PC, Skog JE, Trehane P, Turland NJ, Hawksworth DL. 2000. International Code of Botanical Nomenclature (Saint Louis Code). Königstein. Koeltz Scientific Books, 474 pp.

Grondona I, Hermosa R, García-Acha Y, Sutton, B. 1997. *Pyrenochaeta dolichi*: an example of a confusing species. Mycol. Res. 101: 1405-1408.

Kilpatrick JA, Chilvers GA. 1981. Variation in a natural population of *Epicoccum purpurascens*. Trans. Br. Mycol. Soc. 77: 497-508.

Monte E, Bridge PD, Sutton BC. 1991. An integrated approach to Phoma systematics. Mycopathologia 115: 89-103.

Punithalingam E, Tulloch M, Leach CM. 1972. *Phoma epicoccina* sp. nov. on *Dactylis glomerata*. Trans. Br. mycol. Soc. 59: 341-345.

Schöl-Schwarz MB. 1959. The genus *Epicoccum* Link. Trans. Br. mycol. Soc. 42: 149-173.

Swofford DL. 1998. PAUP*. Phylogenetic Analysis using Parsimony (* and other methods). Version 4. Sunderland, MA: Sinauer Associates.

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Notes on indoor fungi I: New records and noteworthy fungi from indoor environments

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Abstract—Seven fungal species isolated from indoor environments, including four new records for the United States and three other noteworthy taxa, are described and illustrated. The new U.S. records are: *Ascotricha erinacea*, *Sporoschisma saccardoi*, *Stachybotrys microspora*, and *Stachybotrys nephrospora*. The noteworthy fungi are *Ascotricha chartarum*, *Memnoniella echinata*, and *Zygosporium masonii*.

Key words—ascomycetes, hyphomycetes

Introduction

Indoor fungal contamination has recently become a major issue for homeowners, building owners, business owners and the insurance industry, because public awareness of potential detrimental effects of indoor fungi has increased dramatically in the last decade. Morgan-Jones and Jacobsen (1988) described several darkly pigmented moulds, including two new species of *Cladosporium*, associated with biodeterioration of carpet, plaster and wallpaper from hotels in the southern U.S. Samson et al. (2000) described many common airborne fungi from indoors. Flannigan et al. (2001) provided a list of common and important indoor fungi, with brief descriptions. We note that fungi identified from indoor environments are rather diverse and over 600 species have been identified in our laboratory. Over the last fifteen years, we have isolated many unusual fungi from air and from water-damaged building materials. This paper reports four species new to the USA. *Ascotricha chartarum*, *Zygosporium masonii*, and an isolate of *Memnoniella echinata* producing dimorphic conidia are also described.

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Materials and methods

The isolates used in this study were isolated and purified from samples submitted to P & K Microbiology Services for fungal identification and enumeration. The isolates were grown on 2% Malt Extract, 1.5% Agar (MEA), Corn Meal Agar (CMA), or dicholran glycerol agar (DG18) for 1 to 2 weeks at 25 C. Dimension ranges given are based on 30 measurements. If fewer than 30 structures were available, the actual number measured is noted. United States postal abbreviations of State names are used in the distributional records of fungi reported from the United States.

Taxonomy

Ascotricha chartarum Berk. (Figure 1)

Anamorph: *Dicyma ampullifera* Boulanger

Description: Colonies slow-growing, 25-35 mm diam in 36 days on MEA at 25C, dark blue green with a yellowish edge; aerial mycelium yellow. Perithecia dark brown to black, pear-shaped, ostiolate, 94-150 × 60-105 μm (mean = 123 × 87 μm), developing olivaceous to black, geniculate, rigid, erect setae with thin-walled vesicles at geniculate nodes. Asci 8-spored, cylindrical, thin-walled, deliquescing after ascospores mature. Ascospores uniseriate, dark brown to black when mature, smooth, discoid with a distinct equatorial slit, 5.9-8.4 × 4.2-6.4 μm (mean = 7.5 × 5.5 μm).

Conidiophores straight, stiff, profusely branched, up to 1 mm long, 3.5-5.5 μm wide with pale, thin-walled vesicles at the bends. Conidiogenous cells lateral and terminal, cylindrical, sympodial, developing conidia on denticles. Conidia lightly rough, subspherical to ellipsoidal, colorless when young, becoming light brown when mature, 4.5-7.4 × 2.4-3.7 μm (mean = 5.4 × 3.5 μm).

Habitat: plant materials, paper, linoleum, plaster, cardboard, cloth, cork, skin, seeds, soil, and lignum (Hawksworth 1971, Hanlin 1990). Culture 030130-012 was isolated from water-damaged drywall and wood structures from FL.

Distribution: Brazil, China, Denmark, England, France, Germany, India, Italy, New Zealand, Tanzania and USA (FL, NH., MA) (Hawksworth 1971). It was found in indoor environments in AZ, NY and SC.

Remarks: the fungus is a cellulolytic saprobe. It also causes maxillary sinusitis (de Hoog et al, 2000). *Ascotricha chartarum* var. *orientalis* Castell.

& Jacon. was considered to cause dermatoid infection (paracladiosis) (Hawksworth 1971). A dried specimen derived from the culture 030130-012 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

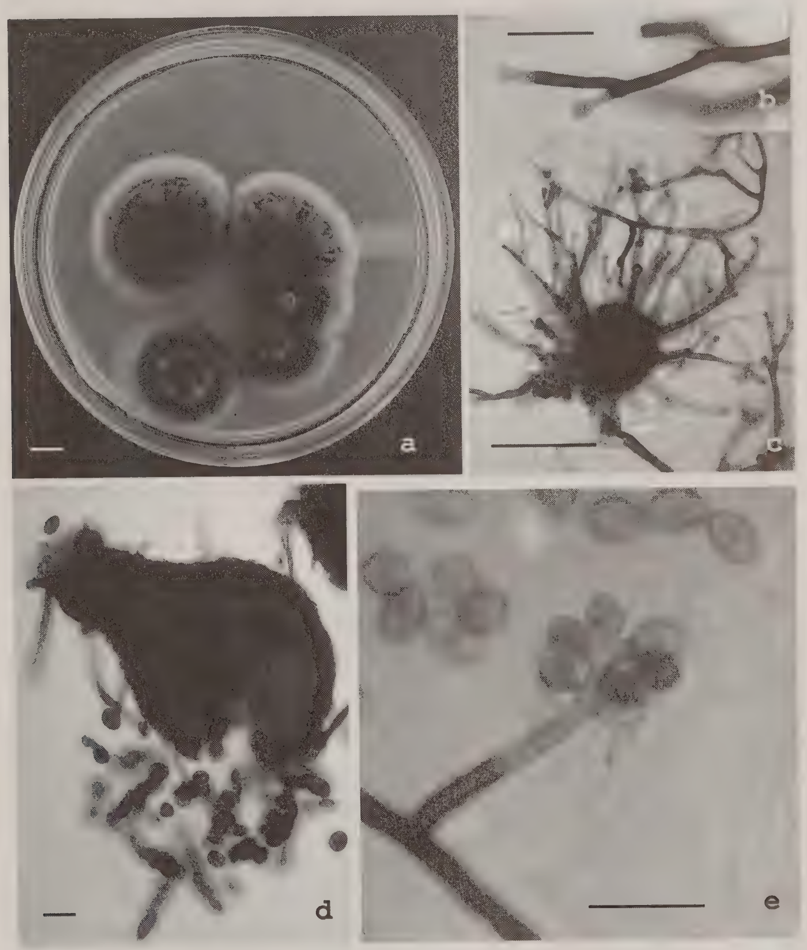

Figure 1. *Ascotricha chartarum* (030130-012). a. Colonies on MEA after 36 days. b. Appendages. c. Perithecia and appendages. d. Perithecia and ascopsores. e. Conidiophores and conidia. Bars: a = 10 mm, b, d, e = 10 μm, c = 100 μm, respectively.

Ascotricha erinacea Zambett. (Figure 2)

Description: Colonies 17-22 mm diam in 7 days on MEA at 25C, green with a raised white center and wavy light brown edge. Conidiophores 44-92 × 2.2-4.8 µm (mean = 60 × 2.9 µm). Conidia 3.7-5.9 × 2.4-3.7 µm (mean = 5.1 × 3.5 µm). Perithecia black, developing among the conidiophores, ostiolate, globose to subglobose, 99-165 × 66-115 µm (mean = 135 × 88 µm). Terminal hairs erect, brown to black, geniculate, often dichotomously and trichotomously branched, remotely septate, narrowing to pointed apices, 4.5-8 µm wide at the base. Lateral hairs sparse or absent, similar to the terminal hairs. Asci 33-72 × 7.8-11 µm (mean = 57 × 8.6 µm). Ascospores 9.4-13 × 5.6-7.4 µm (mean = 12 × 6.5 µm).

Habitat: on paper of water-damaged drywall and wood structures. Culture 021219-026 isolated from indoors in MN.

Distribution: France (Hawksworth 1971) and USA (AZ MD, MN, and NY). It is a new record for the U.S.A.

Remarks: this species was isolated from paper by Zambettakis in 1955. Hawksworth described it in his revision of the genus *Ascotricha*. It appears to be a rare species. We have occasionally encountered it on water damaged paper products or on wood. A dried specimen derived from culture 021219-026 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

Memnoniella echinata (Riv.) Galloway (Figure 3)

Description: Colonies 34 – 37 mm in 21 days on MEA at 25C, gray to dark gray, granular, radially sulcate with irregular edge, reverse light brown. Conidiophores unbranched, colorless at first, olivaceous later, 42-103 µm (mean = 78 µm) long and 2.8-5.6 µm (4.5 µm) wide, branched portion 22-53 µm (mean = 39 µm) smooth to minutely rough. Phialides unicellular, obovoid or ellipsoidal, pale olivaceous, smooth, of two kinds: (1) phialides producing globose conidia 5.6-9.3 × 2.2-3.9 µm (mean = 8 × 3.4 µm), in groups of 3 to 8 (mostly 5); (2) phialides developing oblong conidia 7-9.3 × 3.2-4.3 µm (7.8 × 3.7 µm) in groups of 3 to 4 (mostly 3); terminal, or intercalary because of extension of phialide. Conidia of two kinds: (1) globose, in dry basipetal chains, colorless and smooth-walled at first, later dark olivaceous, coarsely warted, subglobose to globose, 3.2-4.4 × 2.4-4.3 µm (mean = 3.8 × 3.6 µm); (2) oblong to pyriform, smooth to rough, dark olivaceous 5.7-9.3 × 3.3-4.7 µm (mean = 7.9 × 3.7 µm).

Habitat: Indoor air, paper products, textiles, wood (*Hevea brasiliensis*) (Ellis 1971, Florence *et al.* 1998), ginger (Srivastava *et al.* 1998). Culture 021220-067 was isolated from MI.

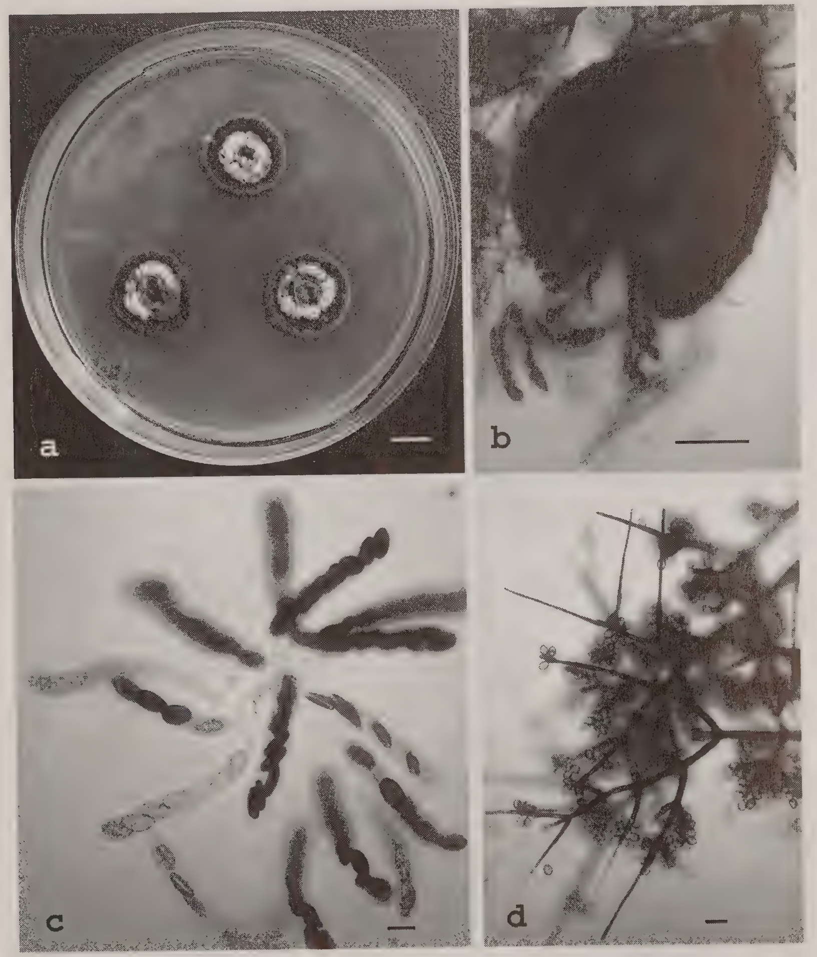

Figure 2. *Ascotricha erinacea* (021219-026). a. Colonies on MEA after 7 days. b. Perithecia. c. Asci and ascospores. d. conidiophores and conidia. Bars: a = 10 mm, b = 40 μm, c, d = 10 μm, respectively.

Distribution: cosmopolitan, but mainly from tropical areas (Domsch *et al.* 1993, Ellis 1971, Jong and Davis 1976). We have identified this fungus from indoor environments in U.S.A. (AZ, CA, FL, HI, IL, LA, MN, NJ, NY, OH, PA, SC, TN, TX, VA, WA, and WI). It was found more often in NJ, NY, and PA.

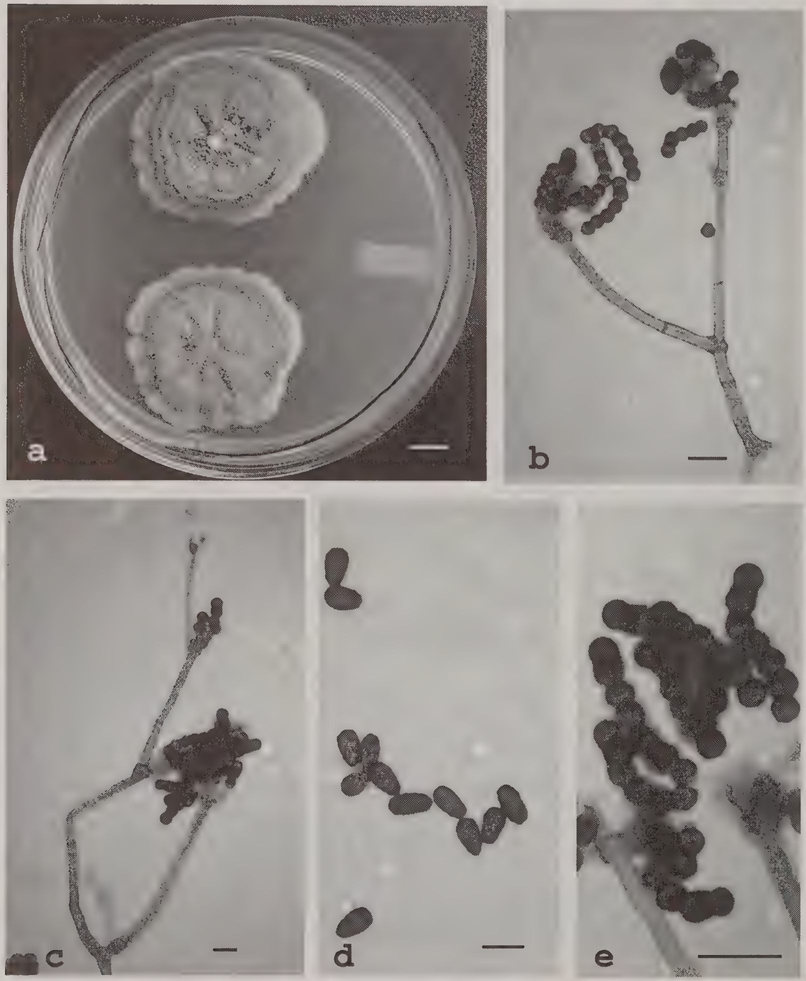

Figure 3. *Memnoniella echinata* (021220-067). a. Colonies on MEA after 7 days. b. Conidiophore with 2 kinds of conidia. c. Proliferation of conidiophore through phialides. d. *Stachybotrys*-type conidia. e. *Memnoniella*-type conidia. Bars: a = 10 mm, b-e = 10 μm, respectively.

Remarks: the fungus produces several mycotoxins: trichodermol, trichodermin, dechlorogriseofulvins, memnobotrins A and B, memenoconol, memnoconone (Jarvis *et al.* 1996). A dried specimen derived from the culture 021220-067 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

Sporoschisma saccardoi Mason & Hughes apud Hughes (Figure 4)

Holomorph: *Melanochaeta hemipsila* (Berk. & Broome) Müller, Harr et Sulmont, Revue de Mycologie 33: 377 (1969).

Description: Colonies restricted, 5 - 8 mm diam in 7 days on MEA at 25C, dark brown to black, covered with grayish aerial mycelium, velvety; reverse dark brown. Conidiophores with terminal phialides, dark brown, smooth, erect, straight, solitary or in groups of 2 to 4, developing very sparsely at center, more profusely at the edge of colonies, 130 – 200 μm (mean = 170 μm) long, 1-septate. Venter of phialides somewhat inflated, 14-20 μm wide (mean =15.6 μm) at inflated portion, apices 11-14 μm wide (mean = 13.5 μm), base 8.4-14 μm wide (mean = 10.8 μm). Conidia in long chains, cylindrical with truncate ends, smooth, dark brown, very dark at the septa, majority 5-septate, the two end cells much shorter and lighter, 32-53 × 11-13 μm (mean = 43 × 11.5 μm), mean conidium length/width ratio = 3.78:1. Developing conidia can be observed through the phialide walls. Capitate hyphae 92-170 × 4.2-5.9 μm (mean = 135 × 5.5 μm), erect, straight, or slightly bent, 2-4-septate, solitary or in pairs, developed in mucilaginous envelopes, mixed with conidiophores; the tips of capitate hyphae are inflated, 7.4-13 × 7.4-13 μm (mean = 10 × 9.5 μm). This fungus sporulates poorly on MEA, but very well on CMA.

Habitat: on wood, especially wet or submerged (Goh *et al.* 1997). Culture 020703-043 was isolated from water-damaged wood structures indoors.

Distribution: Australia, Brunei, Canada, Italy, Hong Kong, Indonesia, Japan, Malaysia, South Africa, South America, Taiwan (Goh *et al.* 1997, Nag Rag and Kendrick 1975, Watanabe 2002), and USA (FL, IL). It is a new record for the U.S.A.

A dried specimen derived from the culture 020703-043 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

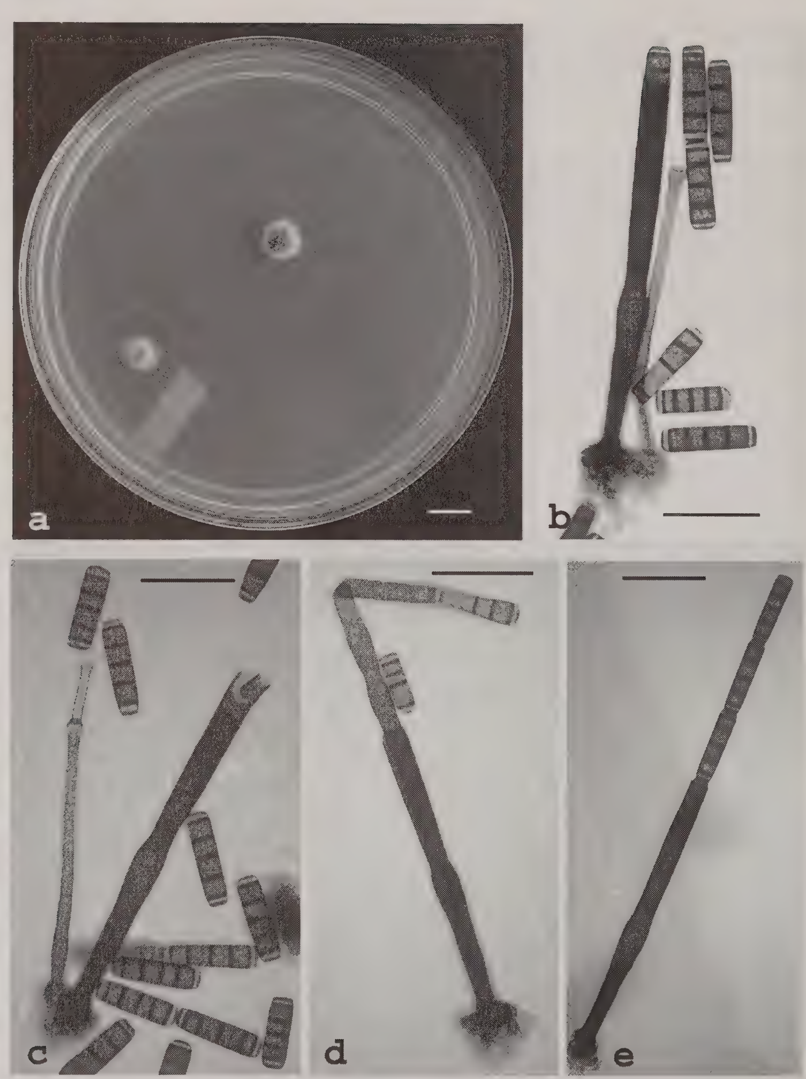

Figure 4. *Sporoschisma saccardoi* (020703-043). a. Colonies on MEA after 17 days. b. Conidiophore, conidia and capitate hypha. c. Percurrent extension of capitate hypha with conidiophore and conidia. d. Extension of conidiophore. e. Conidophores and conidia without vesicles. Bars: a = 10 mm, b-e = 40 μm, respectively.

Stachybotrys microspora (Mathur & Sankhla) Jong & Davis (Figure 5)

Description: Colonies slow growing 16.5 – 19 mm diam in 14 days on MEA at 25C, white with a pink tint; reverse brown; aerial mycelium white; the edges of the colonies irregular. In three weeks the colonies become light gray, still with a light pink tint; clear amber exudates start to develop. After four weeks, the colonies become dark gray to black. Conidiophores differentiated, single, determinate, simple, colorless and smooth, erect, straight, colorless to light brown, smooth, 44-92 × 2.2-4.8 μm (mean = 60 × 2.9 μm). Phialides 7-11 × 3.3-7.4 μm (mean = 8.8 × 4.6 μm) with conspicuous collarettes, in groups of 5-6. Conidia ellipsoidal, olivaceous, smooth to rough, 4.3 - 6.1 × 3.7 – 4.6 μm (mean = 5.4 × 4 μm).

Habitat: paper, soil, seeds, textiles and dead plants (Ellis 1971). It was isolated from paper of water-damaged drywall, and wallpaper, from WA.

Distribution: Canada, Cuba, India, Nigeria, and Pakistan (Ellis 1971). Culture 021020-084 is the first record for the U.S.A.

A dried specimen derived from the culture 021020-084 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

Stachybotrys nephrospora Hansford (Figure 6)

Description: Colonies olivaceous to black, 37 – 42 mm diam in 22 days on MEA at 25C; reverse brown; aerial mycelium white; the edge of the colonies slightly irregular. Conidiophores differentiated, single, determinate, simple, occasionally branched, colorless and smooth, erect, straight or curved (flexuous), 60-150 × 2.5-3.3 μm (mostly 93.6 × 3.2 μm). Phialides obovoid or ellipsoidal, 8-10 × 4.2-6.6 μm (mean = 9 × 5 μm) in group of 2-4 (mostly 3) with conspicuous collarettes. Conidia reniform, colorless at first, becoming olivaceous to nearly black at maturity, smooth to rough, 8.3 – 13 × 5 – 8.3 μm (mean = 10.4 × 6.5 μm).

Habitat: on wood. Culture 021213-012 was isolated from water-damaged wallboard in Florida.

Distribution: Solomon Islands, India, Jamaica, Sierra Leone, Uganda (Ellis 1971). This species is newly recorded for North America. We have seen this fungus three times, from FL and AZ.

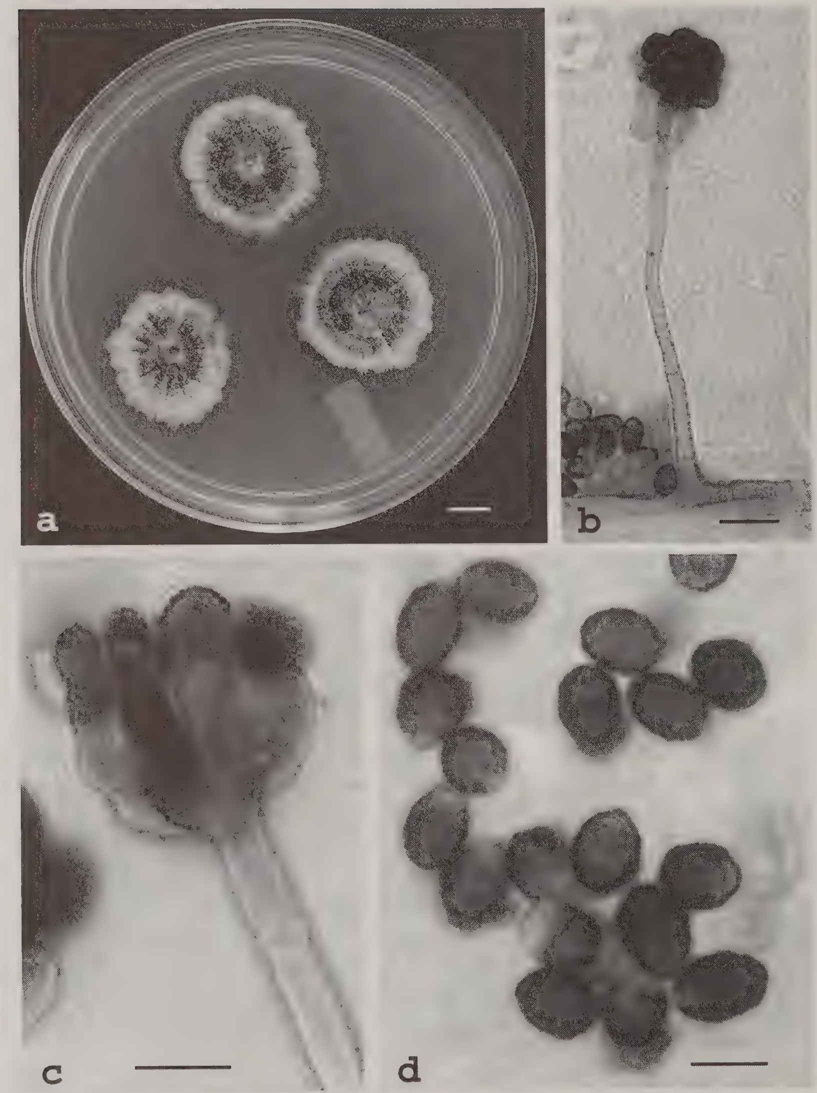

Figure 5. *Stachybotrys microspora* (021030-084). a. Colonies on MEA after 3 weeks. b. Conidiophore and conidia. c. Phialides with immature conidia. d. Conidia. Bars: a = 10 mm, b = 10 μm, c, d = 5 μm, respectively.

A dried specimen derived from the culture 021213-012 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

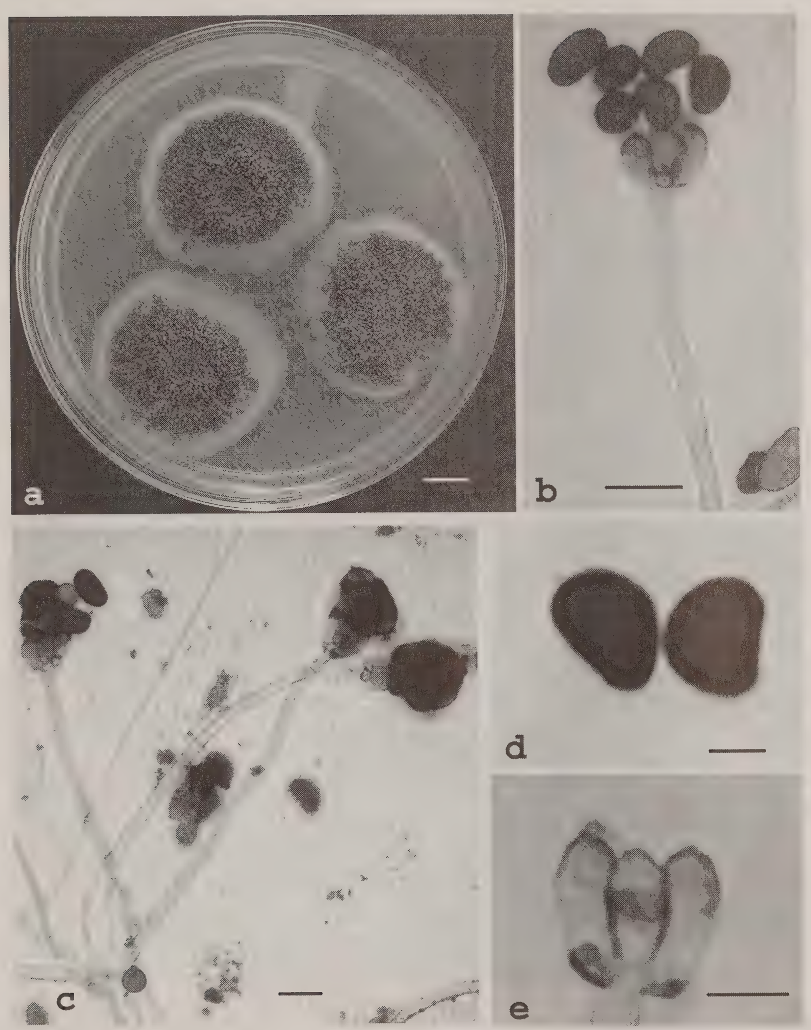

Figure 6. *Stachybotrys nephrospora* (021213-012). a. Colonies on MEA after 7 days. b Conidiophore and conidia. c. Conidia in slimy masses on conidiophores. d. Conidia. e. Phialides. Bars: a = 10 mm, b, c = 10 μm, d, e = 5 μm, respectively.

Zygosporium masonii Hughes (Figure 7)

Description: Colonies slow growing, 4 – 6 mm diam in 7 days on MEA at 25C, raised; aerial mycelium white; reverse brown. Conidiophores differentiated, single, 59-89µm long (mean = 71µm), erect, brown, smooth, with chains of up to 6 integrated vesicles (falces) and a colorless, sterile apical region, which is 15- 39 × 1.1-2.2 µm (mean = 23 × 1.8 µm) and terminates in a small knob. Vesicles (falces) thick-walled, dark brown, reflexed, 7.4-14 × 3.7-7.4 µm (mean = 9.8 × 5.6 µm), each developing 1-3 short, colorless distal conidiogenous cells. Conidiogenous cells monoblastic, discrete, determinate, ellipsoidal, curved, colorless, 3.7- 7.4 × 1.9-3.7 µm (mean = 5.9 × 3.0 µm). Conidia solitary, acrogenous, non-septate, ellipsoidal, colorless, smooth to rough, 3.9- 7.4 × 1.9-3.7 µm (mean = 6.5 × 2.9 µm). Conidiophores develop sparsely on MEA, but more profusely on DG18 medium.

Habitat: dry-wall, wall-paper indoors, air, soil, and dead plant materials. Culture 030201-011 was isolated from AZ.

Distribution: U.S.A. (AZ, southern CA, LA, TX), Assam, Australia, Ghana, Guinea, Hong Kong, India, Jamaica, Japan, Sierra Leone, Tanzania, Venezuela (Barron 1968, Ellis 1971, Matsushima 1975).

Remarks: *Zygosporium* is known to produce cytochalasin, which has cytotoxic effects on membrane function and the contractile mechanisms of cell movement and division (Griffin 1994). It prefers low water activity. A dried specimen derived from the culture 030201-011 is deposited in BPI and CBS. Living cultures are deposited in ATCC.

Discussion

Our observations suggest that *Ascotricha erinacea* is more common than *A. chartarum* in indoor environments, although *A. erinacea* was previously known from France (Hawksworth 1971). Anamorphs of both *Ascotricha chartarum* and *A. erinacea* develop well on MEA and DG18, but their teleomorphs usually fail to develop, or are produced sparsely on the same media. Freshly isolated cultures may develop the teleomorph, but subcultures normally do not produce ascomata.

A number of isolates of *Memnoniella echinata* (021220-067), *M. subsimplex* and *M. longistipitata* were observed to develop both *Stachybotrys*-type and *Memnoniella*-type conidia on the same colonies. *Stachybotrys*-type conidia are more often developed at the edges of colonies. Conidiophores of *Stachybotrys proliferata* Karandikar, Lulkarni & Patwardhan proliferate like those of *M. echinata* (isolate 021220-067) (Karandikar, Lulkarni, and Patwardhan 1992). *Stachybotrys*-type conidia in those isolates of *Memnoniella* spp. developing dimorphic conidia are all more or less oblong.

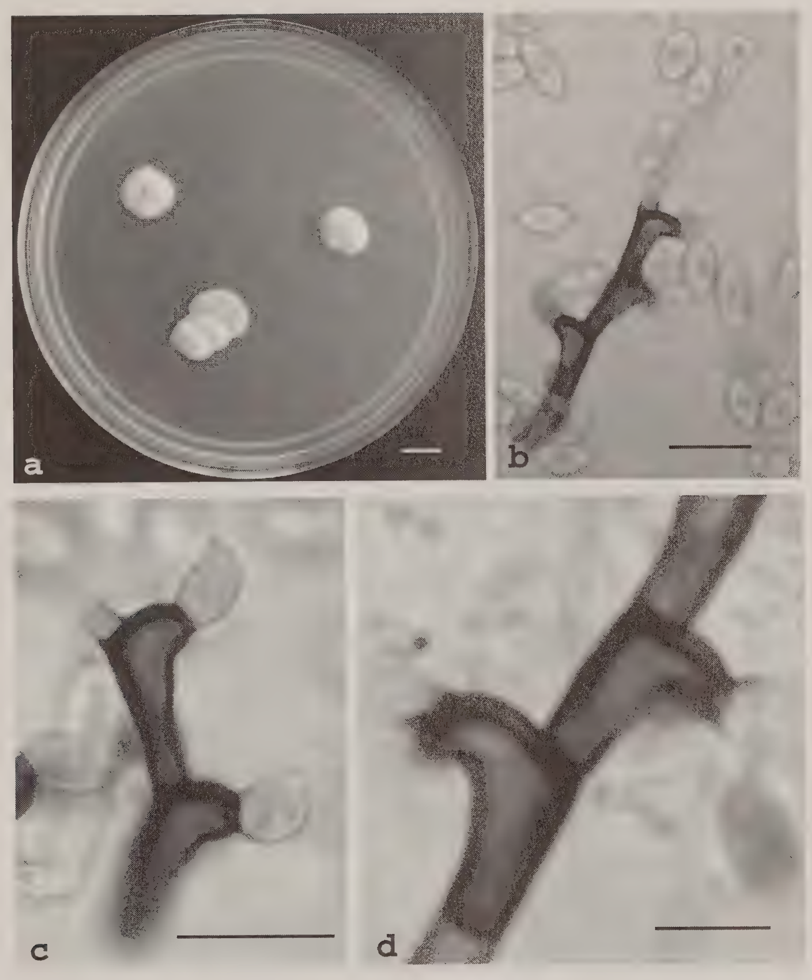

Figure 7. *Zygosporium masonii* (030201-011). a. Colonies on DG 18 after 7 days. b. Conidiophore and conidia. c. Vesicles, conidiogenous cells and conidia. d. Vesicle with collapsed conidiogenous cells. Bars: a = 10 mm, b, c = 10 μm, d = 5 μm, respectively.

But in *M. echinata* (021220-067) while some conidia were oblong or ovoid, a significant portion of the *Stachybotrys*-type conidia were pyriform. This isolate could be a new taxon, but further studies are needed to determine its disposition.

Sporoschisma saccardoi (020703-043) grown on CMA produced a few conidiophores and capitate hyphae showing percurrent extension. Since the percurrent extension of conidiophores is one of important characters differentiating *Sporoschismopsis* from *Sporoschisma, Sporoschisma saccardoi* (020703-043) appears to be intermediate between *Sporoschisma* and *Sporoschismopsis*. This phenomenon raises two questions: 1) whether *Sporoschisma* and *Sporoschismopsis* should be treated as two separate genera; 2) whether the culture we examined should be a new species. To answer above-mentioned questions, further research is necessary. Watanabe (2002) suggested that the capitate hyphae of *S. saccardoi* are possibly in the process of developing into mature conidiophores, but we were unable to confirm this. During the percurrent extension of the capitate hyphae, they remained non-sporulating.

Both *S. microspora* and *S. nephrospora* are reported for the first time in the U.S.A. Without careful examination, both can be confused with *S. chartarum*. Conidia of *S. microspora* are similar to immature or smaller ones of *S. chartarum*. Ellis agreed with Mathur & Sankhla (1966) and treated it as a variety of *S. chartarum* (*Stachybotrys atra* var. *microspora*) (Ellis 1971). Jong and Davis (1976) elevated it to species rank. The comparative sequence analysis conducted by Haugland *et al.* (2001) showed that Jong and Davis were correct. Since the delimitation of *S. microspora* and *S. chartarum* is mainly based on conidial size, it is crucial to measure conidia precisely. Some conidia of *S. nephrospora* may not be reniform due to orientation or stage of development, which can make them appear similar to those of *S. chartarum*. The ecological significance of these closely related species in indoor environments and their effects on human health need more study.

Zygosporium masonii was commonly reported from Europe. In the U.S., it was a laboratory air contaminant in West Virginia, and was isolated from coastal sands of Oahu, Hawaii (Wang and Baker 1967). Recently it has been isolated from indoor environments in southwestern U.S.A. (AZ, CA, TX). Wang and Baker (1967) interpreted conidiogenesis in *Z. masonii* as being phialidic, with a *Sporothrix*-like synanamorph. However, Wang now considers the collarettes observed were probably collapsed conidiogenous cells and that the mode of conidium ontogeny is blastic (personal communication). Hughes (1951) did not consider the conidiogenous cells of this species to be phialides. Ellis (1971) treated them as monoblastic. In our isolates, monoblastic conidiogenous cells predominated. However one conidiophore was found with collarette-bearing conidiogenous cells where conidia can develop directly on vesicles. Each vesicle usually develops 2 conidiogenous cells (Wang and Baker 1967, Ellis

1971), but vesicles may bear 1-3 conidiogenous cells. This species was found in AZ, CA, TX where there is no previous published record. Conidiophores with conidia still attached were observed in an air sample. Meredith (1962) found that the conidia of *Z. oscheoides* Mont. are violently discharged. This may explain why species of *Zygosporium*, an unusual genus, are found in air samples from time to time.

Acknowledgments

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Literature cited

Carmichael JW, Kendrick, WB, Conners I.L, Sigler L. 1980. Genera of Hyphomycetes. Edmonton: University of Alberta Press. 386 p.

de Hoog GS, Guarro J, Gené J, Figueras MJ. 2000. Atlas of Clinical Fungi. 2nd Edition. Centraalbureau voor Schimmelcultures/Universitat Rovira I Virgili. 1126 pp.

Domsch KH, Gams W, Anderson T-H. 1993. Compendium of Soil Fungi, Volume 1. Trante-Heidi Anderson Institute of Soil Biology, Federal Agricultural Research Centre, Braunschweig, Federal Republic of Germany. IHW-Verlag, 860pp.

Ellis MB. 1971. Dematiaceous Hyphomycetes. CAB International, Wallingford, Oxon. 608 pp.

Ellis MB. 1976. More Dematiaceous Hyphomycetes (Volume 2) CAB Interantional Wallingford, Oxon. 507 pp.

Flannigan B, Samson RA, Miller JD. 2001.Microorganisms in Home and Indoor Work Environments. Taylor & Francis, London and New York.

Florence EJM, Sharma JK, Gnanaharan R. 1998. Sapstain fungi associated with softwood species in Kerala, India. International Research Group on Wood Preservation. IRG Secretariat, Stockholm, Sweden: No. IRG\WP\98-10260, 11 pp. 29th Annual Meeting, Maastricht, Netherlands, 14-19 June 1998.

Goh TK, Ho WH, Hyde KD, Umali TE. 1997. New records and species of *Sporoschisma* and *Sporoschismopsis* from submerged wood in the tropics. Mycol. Res. 101: 1295-1307.

Griffin DH. 1994. Fungal Physiology, 2nd Edition. Wiley- Liss, New York. 458 pp.

Hanlin R. 1990. Illustrated Genera of Ascomycetes. APS Press, St. Paul, MN.

263 pp.

Haugland RA, Vesper SJ, Harmon S. 2001. Phylogenetic Relationships of *Memnoniella* and *Stachybotrys* Species Inferred from Ribosomal DNA Sequences and Evaluation of Morphological Features for *Memnoniella* Species Identification. Mycologia. 93:54-65.

Hawksworth DL. 1971. A revision of the genus *Ascotricha* Berk. Mycol. Pap. 126. Commonwealth Mycological Institute, Kew, Surrey, England. 28 + V pp.

Javis BB, Zhou Y, Jiang J, Wang S, Sorenson WG, Hintikka EL, Nikulin M, Parikka P, Etzelm RA, Dearbone DG. 1996. Toxigenic molds in water-damaged buildings. Dechlorogriseofulvins from *Memnoniella echinata.* J. Nat. Prod. 59: 552-553.

Jong, SC, Davis EE. 1976. Contribution to the knowledge of *Stachybotrys* and *Memnoniella* in culture. Mycotaxon 3: 409-485.

Karandikar KG, Lulkarni SM, Patwardhan PG. 1992. Some new and interesting Hyphomycetes from India. Biovigyanam 18: 78-81.

Mathur BL, Sankhla HC. 1966. A new variety of *Stachybotrytis atra* from Rajasthan soil. Science & Culture 32: 93-94.

Matsushima T. 1975. Icones Microfungorum a Matsushima Lectorum. Published by author, Kobe, Japan. 209 pp + 415.

Meredith DS. 1962. Spore discharge in *Cordana musae* (Zimm.) Höhnel and *Zygosporium oscheoides* Mont. Ann. Bot. 26: 233-241.

Morgan-Jones G, Jacobsen BJ. 1988. Notes on hyphomycetes. LVIII. Some dematiaceous taxa, including two undescribed species of *Cladosporium*, associated with biodeterioration of carpet, plaster and wallpaper. Mycotaxon 32: 223-236.

Nag Rag TR, Kendrick B. 1975. A Monograph of *Chalara* and Allied Genera. Wilfrid Laurier University Press, Waterloo, Ontario 200 pp.

Samson R, Hoekstra ES, Firsvad JC, Filtenborg O. 2000. Introduction to Food- and Airborne Fungi. 6th Edn. CBS, Utrecht, Netherlands.

Srivastava LS, Gupta SR, Basnet CP, Mahato UP, Neopani B. 1998. Microorganisms associated with ginger in Sikkim. Journal of Hill Research 11: 120-122.

Wang CJK Baker GE. 1967. *Zygosporium masonii* and *Z. echinosporium* from Hawaii. Can. J. Botany 45:145-152.

Watanabe T. 2002. Soil and Seed Fungi: Morphologies of cultured fungi and key to species. (2nd Edn.) CRC Press, Boca Raton, FL. 486 pp.

Zambettakis C. 1955. Un nouveau champignon papyricole. Bull. Soc. Bot. Fr. 102: 219-225.

Zuck RK. 1946. Isolates intermediate between *Stachybotrys* and *Memnoniella.* Mycologia 38: 69-76.

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Notes on dictyostelid cellular slime molds from Taiwan (2): *Dictyostelium exiguum* and its ITS-5.8S rDNA sequences

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Abstract—During a survey of dictyostelid cellular slime molds in 2002, *Dictyostelium exiguum* was isolated from forest soils and was identified as new record for Taiwan. This isolate was morphologically examined and is illustrated in this text. The nucleotide sequences of internal transcribed spacer (ITS) regions and 5.8S of ribosomal DNA were also analyzed. The *D. exiguum* sequence lengths of ITS 1, 5.8S, and ITS 2 were 250 bp, 170 bp and 461bp, respectively.

Key words—dictyostelids, ribosomal RNA gene

Introduction

The taxonomic studies of dictyostelid cellular slime molds in Taiwan have been briefly reviewed in previous papers (Yeh & Chien 1983; Hagiwara et al. 1992; Lin & Yeh 1999; Fan & Yeh, 2001; Hsu et al. 2001; Fan et al. 2002; Yeh 2003). During a 2002 survey of forest soils in Nantou County, central Taiwan, *Dictyostelium exiguum*, was isolated. This was a new record for Taiwan. This isolate was examined and is illustrated here. Moreover, internal transcribed spacer (ITS) and 5.8S ribosomal DNA (rDNA) sequences were also determined. The examined specimens and pure cultures were deposited in the Mycology Laboratory, Department of Life Science, National Taiwan Normal University, Taipei, Taiwan, R. O. C.

Materials and Methods

Morphology

Soil samples were collected from forest floor from Nantou County, central Taiwan, in 2002. Five to ten grams of each soil sample were suspended in 50 ml of distilled water. A small amount of the suspension was spread over the surface of 0.1% lactose yeast-extract agar plates (Norberg 1971). The agar plates were then incubated in darkness at 25°C. When the fruiting structures developed, a sterilized needle was used to remove the spores from the sorocarps and transfer them to a fresh agar plate with a suspension of pre-grown *Escherichia coli*. The plate was examined for one or two weeks to follow the life cycle. Methods used for observations and measurements of this species follow Hsu et al. (2001). The taxonomic system of Hagiwara (1983) was followed for identification.

Genomic DNA extraction

Genomic DNA was extracted from spores using a variation of CTAB method described by Wang & White (1997) as adapted from Doyle & Doyle (1990). Seventy spores were collected from pure cultures of *D. exiguum* in a microfuge tube. After adding a small amount acid-washed sea sand, the spores were homogenized with a “microfuge pestle”. Then 500 μl pre-warmed 2% CTAB extraction buffer (1.4 M NaCl, 100 mM Tris-HCl, pH 8.0, 20 mM EDTA, 2% PVP-40 w/v, 20 mM cetyl trimethyl ammonium bromide (CTAB), and 0.5%2-mercaptoethanol v/v) was added into the mixture before grinding more. The mixture was incubated for 10 min at 65°C to break the cell membranes. The tissue/buffer mixture was then emulsified with 500 μl dichloromethane:isoamyl alcohol (24:1) to separate protein from DNA before spinning in a microfuge for 2 min at room temperature. The top phase was transferred to a fresh microfuge tube and 300 μl of isopropanol was added to precipitate the DNA. After spinning for 2 min at room temperature, the supernatant was carefully poured off. Then 500 μl wash buffer was added and was left for 2 min. After spinning for 2-3 min, the supernatant was discarded. The pellet was resuspended in 35 μl~ 40 μl double distilled water. Two to 5 μl DNA solution was used for the PCR reaction.

PCR amplification

The oligonucleotide primers 18S-F (GAGAAGTCGTAACAAGGTATC) and 5.8S-R (GAATTATCGCAGTTTGCTACG) were used to amplify fragments containing ITS1. Another pair of oligonucleotide primers 5.8S-F (CGTAGCAAAC-TGCGATAATTC) and ITS4 (TCCTCCGCTTATTGATATGC) were used to amplify fragments containing ITS 2. A 100 l reaction mixture contained 1.0 mM of each primer, 2.5 units Taq DNA polymerase, 100 M each of the four deoxynucleotides, dATP, dCTP, dGTP, and dTTP, in a PCR reaction buffer (10 mM Tris-HCl, 1.5 mM $MgCl_2$, 50 mM KCl, 0.1 mg gelatin ml-1, pH 9.0), and 2 to 5 μl DNA. PCR products were amplified in a Perkin Elmer DNA Thermal Cycler using the following programme: 94°C for 5 min for denaturation of DNA, followed by 40 cycles at 94°C for 1 min, and 50°C for 1 min for primer annealing, then at 72°C for 2 min extension. PCR amplification templates containing no DNA, were carried out in every experiment as controls to test for contamination of reagents and reaction mixtures by non-sample DNA. Efficiency of amplification was monitored by running 7 μl of each reaction through a 2% agarose gel at 125 V for 3 h in Tris-borate-EDTA buffer (0.44 M boric acid, 0.44 M Trizma base, and 10 mM EDTA), a 100-bp molecular weight ladder (Gene RulerTM) was used as the size standard, stained with ethidium bromide, and visualized and photographed under ultraviolet light.

Sequencing of amplified DNA

Fragments containing ITS 1-5.8S and 5.8S-ITS 2 were amplified from the test cultures of *D. exiguum*. The PCR-amplified products were sequenced using an automated DNA sequencer following the manufacturer’s protocols (ABI 3730 DNA Analyzer Applied Biosystems, USA).

Results

Taxonomic Description

Dictyostelium exiguum Hagiwara, Bull. Natn. Sci. Mus., Tokyo, Ser. B, 9(4):149, 1983. Fig. 1.

Sorocarps, solitary or gregarious, unbranched or sparsely branched. Sorophores colorless, sinuous, tapering from bases to tips, ranging from 1.8 to 6.8 mm; bases clavate, 25-36 µm in diam at a level 50 µm above the bottom; tip capitate or somewhat widened, 9.7-16 µm in diam at a level 50 µm below the tip. Sori white, globose, 50-200 µm in diam. Spores hyaline, ellipsoid, with conspicuous consolidated polar granules, mostly 5.5-7.7×2.2-3.3 µm. Pseudoplasmodia with radiate streams, ranging from 0.08-2.6 mm in diam, converging at single center or breaking up into several small aggregation centers.

Distribution: In forest soils of central Taiwan. Known from Nepal and Taiwan.

SPECIMEN EXAMINED: **TAIWAN**. **Nantou County**. Yeh ZY. *Tai 2002-1*.

Comment: This species is characterized by the small sorocarps, the thick clavate sorophore bases and the small spores. Taiwanese isolates examined in this study had somewhat larger spore size and longer sorophore than the type specimen (Hagiwara 1983).

Amplification and sequencing of ribosomal RNA gene

The total nucleotide sequence lengths of the products were 1042 bp containing partial 18S and 28S ribosomal RNA gene. They are listed in Table 1.

Discussion

Hagiwara (1983) first reported this species from Nepal. There, this species is found in the surface soil and leaf mold of open forests in the Gosainkund region and the Gokarna Forest (1,350 m). Hagiwara (1990) also obtained some isolates from open oak-laurel forest (1,910-2,150 m) on Mt. Phulchoki, Nepal. In Taiwan, *D. exiguum* was isolated only from Nantou County (ca. 1,000 m), located in central Taiwan. It was also found in the surface soil of a mixed forest of oak-pine and other broad-leaved trees. Nepal extends along the Himalayan range between the latitudes of 26°22'N and 30°27'N. The country has an area of 147,000 sq km. Two-thirds of the area is occupied by hills and mountains, which arise at about 60 m in the south to the crest of the Himalayas reaching over 8,000 m in the north. Average temperature ranges in Kathmandu (the capital) are from 2-20°C in January to 26-32°C in June. Dobremez (1972) divided the vegetation of Nepal into six bio-climate belts, namely, (1) tropical belt (below 1,000 m alt.): dominated by *Shorea*, *Terminalia*, *Eugenia* and *Cassia* spp. etc, (2) subtropical belt (1,000-2,000 m alt.): *Schima-Castanopsis* forest in the east and *Pinus* forest in the west, (3) temperate belt (2,000-3,000 m alt.): characterized by evergreen oaks, rhododendrons, conifers etc with deciduous maples, (4) sub-alpine belt (3,000-4,000 m alt.): represented by *Abies*, *Betula*, *Acer* and *Sorbus* spp. etc. (5) alpine belt (4,000-5,000 m alt.) and (6) Nival belt (above 5,000 m alt.): dominated by rhododendron bushes, *Berberis* shrub and primroses herbs etc.

Taiwan is an island along the western edge of the Pacific Ocean. It is located across the Tropic of Cancer. Extending 394 km along its longest axis (25°20'N to 21°55'N) and stretching 140 km at its broadest transection, this island measures about 35,800 sq km. In the lowlands, the average temperature is about 26-30°C in summer and 15-23°C in winter. According to Hsieh et al. (1994), five principal forest vegetation belts can be distinguished along the altitudinal distribution, namely, (1) costal vegetation: represented by mangroves, sand-dune plants, and littoral forests, (2) lowland vegetation (below 500 m alt.): including *Ficus-Machilus* forests, secondary forests, and grasslands, (3) montane vegetation (500-2,500 m alt.): dominated by *Machilus-Castanopsis* forests, evergreen oak forests, beech forests, mixed coniferous forests, pine forests, and *Tsuga-Picea* forest, (4) subalpine vegetation (2,500-3,700 m alt.): characterized by *Abies* pure stands, *Berberis* shrub, some *Quercus* trees, and *Yushania* dwarf bamboo thickets, (5) alpine vegetation (3,500-3,900 m alt.): including *Rhododendron* and *Lycopodium* communities etc.

To date, there are two species of dictyostelids found only in Nepal and Taiwan: *D. clavatum* Hagiwara (Hagiwara 1992; Fan et al. 2002) and *D. exiguum*. As Taiwan is close to Nepal geographically and *D. exiguum* was isolated from similar habitats in these two sites, we suggest that *D. exiguum* as well as *D. clavatum* ultimately will be classified as a subtropical species after further investigation.

Current molecular approaches, especially sequences of ribosomal RNA gene (rDNA), are used to assist in studying taxonomic problems and in understanding the phylogenetic relationships among fungal groups (Zambino & Szabo 1993; Berbee et al. 1995; Moncalvo et al. 1995; Mitchell & Bresinsky 1999; Lohtander et al. 2000; Tuthill et al. 2001; Chou & Wu 2002; González et al. 2002; Hofstetter et al. 2002; Legrève et al. 2002; Liu et al. 2002). Ribosomal DNA sequences of *D. exiguum* based on ITS-5.8S gene totalled 881 bp and were registered in GenBank (accession number: AY170307).

Compared to the nucleotide sequences of the other dictyostelids registered in GenBank, *D. exiguum* was similar to *D. aureo-stipes* Cavender, Raper et Norberg var. *aureo-stipes*. There was 93% (286/306) identity between them after making sequence alignment in National Center for Biotechnology Information (NCBI) resources.

According to Ozaki et al. (1984), the ITS-5.8S rDNA sequences of *D. discoideum* Raper are 1078 bp and are longer than that of *D. exiguum*. The A+T contents revealed minor differences between these two species. In particular, the ITS 1- 5.8S- ITS 2 for *D. discoideum* is 74%-57%-57% (Ozaki et al. 1984), for *D. exiguum* was 64%-50%-63% (Table 1). With the development of additional dictyostelid rDNA sequences, it will be possible to construct the phylogenetic relationships within this group.

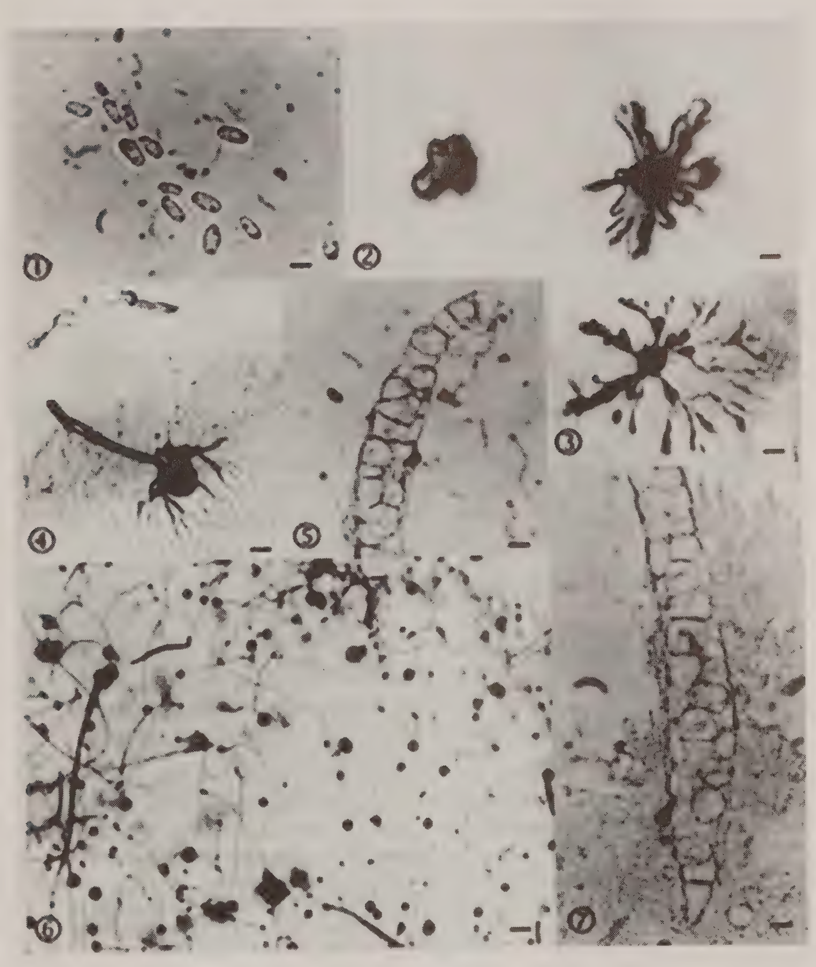

Fig. 1. *Dictyostelium exiguum* found in 2002 in forest soils of Nantou County, central Taiwan. 1. Spore, 2~3. Aggregation of myxoamoebae, 4. Pseudoplasmodia, 5. Sorophore tip, 6. Mature sorocarps, and 7. Sorophore base. Scale bars: 1 = 5 μm, 2 = 150 μm, 3 = 125 μm, 4 =150 μm, 5 = 5 μm, 6 = 180 μm, 7 =10 μm

Table 1. rDNA sequences of *Dictyostelium exiguum*

rDNA regions	Sequences
Partial 18S (44 bp)	GTCGTAACAA GGTATCGGTA GGTGAACCTG CCGATGGATC ATTA
ITS1 (250 bp) (G+C content =35.60%)	ACACAATGTC CATCCATTCA GTTTTGTAAA AGAGGAAAGA ATGAGCAATC ATTACTAGAA TCTTTATCAA TTCTTTATGG GTATACCCAT GTATACCTCT CAATTTTTTT ACGTTTATTC AACTATATTC TATGCCGCAC AACGCCAAAG ACATTGACTT AGGTCTTGTC TAAGGCTAGG GGTGAGCATT TTCAATGACT CCAGTGTTTC TCTTTCATAG AGATCCTACT GAAATTGTCA AAGAAAGCAT
5.8S (170 bp) (G+C content =50%)	AGGCACATTT GGTCGATACC TCGGCTCTCG AATCGACGAA GACCGTAGCA AACTGCGATA ATTCACTTGA ATTGTAGCGT TTACCGCGAT AGTCGAACTG TTGAACGCAC ATGATGACCG ACTGTCCCTT GCAAAAGGGG CAGCTAGGCC ACTCTCGTTT GAGAGACCTT
ITS2 (461 bp) (G+C content =36.88%)	TTCTCTATCT CTCATACTAA TTTATTATTA GTTTAGGGGC GTTGTGAATG ATGATGAACT AAGTCTGCAT ATATACGGGT CATCATTCAT TAAATATTAT AGTCCAATGC AGTCCTTGAC TTACTACCAA TTGGTAAGAG GTCTTTGCTT AGACACGTTG ATCGCTGTCA CTTTAACTTG GTGGGACTAA CATAGTCTTT TGGAATTTTT CCATTTACCA TTCTTAAACT TTGAAAAGAG ACTCGCGAGC TTTGGCTTGC TTGAGACCTT GATTTGGTTT TGAAAGGTTT TGGGAGTATA GTTTCATTAA GGCCTTCGAG GTTTTCGTCA TTTATAAGGT TTGGATCTGT TGAGCCGTGT CTTTTTGAGC AAGTCTCTTG GCTTTGGTTT TAGTATTTTC TATGGTTCGA CTAATCAAAG ACTAATTCAA AAGTATCAAG TCCCCTGTGG ACTTTGATCA T
Partial 28S (117 bp)	GTAACTCTTG AAGTCGTTAA AGGCTTTCTC AAGATACATC TTTTTGAAGG CTTTCTCAAG ATACATCTTT TTGAATTGGC AAAACTTAAA ACTTAATTAT AGGTCATCAG ACGAGAG

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Literature Cited

Berbee ML, Yoshimura A, Sugiyama J, Taylor JW. 1995. Is *Penicillium* monophyletic? An evaluation of phylogeny in the family Tricholomaceae from 18S, 5.8S and ITS ribosomal DNA sequence data. Mycologia 87:210-222.

Chou HH, Wu WS. 2002. Phylogenetic analysis of internal transcribed spacer regions of the genus *Alternaria*, and the significance of filament-beaked conidia. Mycol. Res. 106:164-169.

Dobremez JF. 1972. Les grandes divisions phytogeographiques du Nepal et de l'Himalaya. Bull. Soc. Bot. France 119:111-120.

Doyle JJ, Doyle JL. 1990. Isolation of plant DNA from fresh tissue. Focus 12:13.

Fan YC, Yeh ZY. 2001. Notes on a dictyostelid cellular slime mold new to Taiwan. BioFormosa 36:43-46.

Fan YC, Chen JW, Yeh ZY. 2002. Notes on dictyostelid cellular slime mold of Taiwan (I): *Dictyostelium minutum* and *Dictyostelium clavatum*. Taiwania 47:31-36.

González V, Arenal F, Platas G, Esteve-Raventos F, Peláez F. 2002. Molecular typing of Spanish species of *Amanita* by restriction analysis of the ITS region of the DNA. Mycol. Res. 106:903-910.

Hagiwara H. 1983. Four new species of dictyostelid cellular slime molds from Nepal. Bull. Natl. Sci. Mus. Tokyo, Ser. B, 9:149-158.

Hagiwara H. 1990. Enumeration of the dictyostelid cellular slime molds obtained from Mt. Phulchoki in the Kathmandu Valley, Nepal. In: Watanabe M. and S. B. Malla (eds.), Cryptogams of the Himalayas, Vol. 2:23-32. National Science Museum, Tokyo.

Hagiwara H. 1992. *Dictyostelium clavatum* sp. nov. and *Dictyostelium medium* sp. nov.: new dictyostelid cellular slime molds from Nepal. Bull. Natl. Sci. Mus. Tokyo, Ser. B, 18:1-6.

Hagiwara H, Chien CY, Yeh ZY. 1992. Dictyostelid cellular slime molds of Taiwan. Bull. Natl. Sci. Mus. Tokyo, Ser. B, 18:39-52.

Hsieh CF, Shen CF, Yang KC. 1994. Introduction to the flora of Taiwan, 3:floristics, phytogeography, and vegetation. In: Huang, T. C. et al. (eds.), Flora of Taiwan, 2nd ed. vol.1. Committee of flora of Taiwan, Taipei, ROC, pp.7-16.

Hofstetter V, Clémencon H, Vilgalys R, Moncalvo J-M. 2002. Phylogenetic analysis of the Lyophylleae (Agaricales, Basidiomycota) based on nuclear and mitochondria rDNA sequences. Mycol. Res. 106: 1043-1059.

Hsu SL, Fan YC, Ma MS, Chou HM, Yeh ZY. 2001. *Dictyostelium delicatum*, a new record of dictyostelid cellular slime mold to Taiwan. Tawania 46: 199-203.

Legrève A, Delfosse P, Maraite H. 2002. Phylogenetic analysis of *Polymyxa* species based on nuclear 5.8S and internal transcribed spacers ribosomal DNA sequences. Mycol. Res. 106: 138-147.

Lin SP, Yeh ZY. 1999. Six species of dictyostelid cellular slime molds isolated from Yang-Ming Shan district of Taipei. Biol. Bull. Natl. Taiwan Normal Univ. 34: 69-80. (In Chinese)

Liu ZY, Liang ZQ, Liu AY, Yao YI, Hyde KD, Yu ZN. 2002. Molecular evidence for teleomorph-anamorph connections in *Cordyceps* based on ITS-5.8S rDNA sequences. Mycol. Res. 106:1100-1108.

Lohtander K, Källersjö M, Moberg R, Tehler A. 2000. The family Physciaceae in Fennoscandia:

phylogeny inferred from ITS sequences. Mycologia 92:728-735.

Mitchell AD, Bresinsky A. 1999. Phylogenetic relationships of *Agaricus* species based on ITS-2 and 28S ribosomal DNA sequences. Mycologia 91:811-819.

Moncalvo J-M, Wang HH, Hseu RS. 1995. Phylogenetic relationships in *Ganoderma* inferred from the internal transcribed spacers and 25S ribosomal DNA sequences. Mycologia 87:223-238.

Norberg A. 1971. The *Dictyostelium mucoroides* complex. University Microfilms International, Ann Arbor, Michigan 127 pp.

Ozaki T, Hoshikawa Y, Iida Y, Iwabuchi M. 1984. Sequence analysis of the transcribed and 5' non-transcribed regions of the ribosomal RNA gene in *Dictyostelium discoideum*. Nucleic Acid Res. 12:4171-4184.

Tuthill DE, Frisvad JC, Christensen M. 2001. Systematics of *Penicillium simplicissimum* based on rDNA sequences, morphology and secondary metabolites. Mycologia 93:298-308.

Wang PH, White JG. 1997. Molecular characterization of *Pythium* species based on RFLP analysis of the internal transcribed spacer region of ribosomal DNA. Physiol. Mol. Plant Pathol. 51:129-143.

Yeh ZY, Chien CY. 1983. Cellular slime molds in Taiwan (I). Biol. Bull. Natl. Taiwan Normal Univ. 18:69-86.

Yeh ZY. 2003. Biodiversity inventory of dictyostelid cellular slime molds in Taiwan. Mycotaxon 86:103-110.

Zambino PJ, Szabo LJ. 1993. Phylogenetic relationships of selected cereal and grass rusts based on rDNA sequence analysis. Mycologia 85:401-414.

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A new and unusual species of *Inocybe* (Inosperma clade) from tropical Africa

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Abstract—A new African agaric, *Inocybe misakaensis*, is described from tropical dry Miombo woodlands in Zambia. *Inocybe misakaensis* lacks pleurocystidia and has smooth yellowish brown basidiospores, fusiform to fusiform-rostrate cheilocystidia, and necropigmented basidia. Phylogenetically, *I. misakaensis* is sister to section *Cervicolores* in the Inosperma clade with strong bootstrap support based on RPB2 nucleotide sequence data. Despite the possession of necropigmented basidia, *I. misakaensis* is related to *I. calamistrata* and allies. A taxonomic description, illustrations, and the phylogeny of this new paleotropical species are presented.

Keywords—*Agaricales, Cortinariaceae,* phylogeny, RNA polymerase II, taxonomy

Introduction

Several new species of *Inocybe* (Fr.) Fr. have been described recently from Zambia and Cameroon (Buyck & Eyssartier 1999; Watling 2001). Here we propose as new, *I. misakaensis sp. nov.*, a species collected in native Miombo woodlands, a seasonally burnt tropical habitat that includes ectomycorrhizal caesalpinioid legumes of the *Fabaceae* and *Uapaca* of the *Uapacaeae* in the Copperbelt Province of Zambia (Högberg & Piearce 1986).

Anatomically, *I. misakaensis* exhibits basidia that fill with ochraceous contents and collapse after basidiospore discharge, similar to members of subgenus *Mallocybe* Kuyp. (Kuyper 1986). Kuyper referred to this character state as necropigmented basidia. For short, we use the term necrobasidia. Species of subgenus *Mallocybe* are distributed in temperate climates of the northern hemisphere and Australasia (Matheny, unpublished). Despite the anatomical similarity to subgenus *Mallocybe*, *I. misakaensis* would appear to represent an undescribed species because of its peculiar cheilocystidia morphology and paleotropical distribution. To test this hypothesis, we sequenced a portion of RPB2 (Liu, Whelen, & Hall 1999; Matheny 2004) to determine the phylogenetic status of *I. misakaensis*. RPB2 encodes the second largest subunit of RNA polymerase II and is appropriate to investigate the phylogeny of the genus *Inocybe* and elements within it (Matheny 2004).

Methods and materials

Collections were made fresh by the second author. Color notations follow that of Ridgway (1912) and Munsell Soil Color Charts (1954). The holotype and paratype are deposited at E; the isotype is deposited at WTU. Herbarium abbreviations follow that of Holmgren, Holmgren, and Barnett (1990).

Sections of dried material were rehydrated in 3% KOH. Dimensions of basidiospore length, width and Q values (ratio of length to width) are presented in a range with outliers enclosed in parentheses, following that of Matheny, Aime, & Henkel (2003). Means of spore length, width, and Q values are italicized. Drawings were made with the assistance of a drawing tube. Spores were drawn at 2000x and basidia and cheilocystidia at 800x.

DNA extraction, polymerase chain reation (PCR) amplification, direct sequencing, and cloning follow that of Matheny et al. (2002) and Matheny (2004). Primers 6F and 7.1R (Liu, Whelen, & Hall 1999; Matheny 2004) were used for PCR amplification and direct sequencing of conserved domains 6 to 7 in RPB2. Clones of the undescribed *I. "serpentinocystis"* from Western Australia were sequenced according to the manufacture's protocol (TOPO TA Cloning and TOPO One Shot kits, Invitrogen, Carlsbad, California, USA). This was done because of a faint PCR band for this product. RPB2 accession numbers for the taxa used in this paper are available on GenBank. These include AY333309, AY333311, and AY333763-AY333778. Collections from which the sequences were obtained, and their herbaria, are provided in the appendix.

DNA sequences were aligned using Clustal X (Thompson et al. 1997). The alignment is available online at TreeBASE (M1620). The maximum likelihood (ML) criterion was used in PAUP* (Swofford 2003) to analyze the phylogenetic placement of *I. misakaensis* in relation to samples from other major clades of *Inocybe* (Matheny, 2004). The ML tree was recovered using a heuristic search with the "as-is" addition sequence. The underlying model of evolution used in the ML analysis was estimated by MODELTEST 3.0 (Posada & Crandall 1998, 2001). Bootstrap values (Felsenstein 1985) greater than 50% derived from a maximum parsimony (MP) analysis using a heuristic search are placed above branches to gauge support for branches in the topology. *Crepidotus (Crepidotaceae)* was used to root the tree because a more inclusive analaysis (Matheny 2004) places *Crepidotus* as sister to *Inocybe*.

Taxonomy

Inocybe misakaensis sp. nov. Figs. 1 a-c.

Metuloidae nullae. Basidia plena necropigmenti. Cheilocystidia 26-61 x 7-10 μm, fusiformes-rostellatae vel fusiformes-rostriformes vel clavatae, membrana tenui praedita. Sporae laeves, 8.0-10.0 x 5.0-6.0 μm. Pileus fibrillosus grosse, haud rimosus, alutaceus interdem cum disco fulvo. Lamellae adnatae, confertae, "Cinnamon-

Buff" vel "Clay Color", pallidae-fimbriatae. Stipe 3.0 cm x 3-4 mm, aequalis, pallidus vel subalutaceus, sericeus vel furfuraceus-fibrillosus, haud pruinosus. Dispersa, humi, cum arboribus leguminosis et *Uapacae*. Holotypus hic designatus in E (Wat. 24837), isotypus in WTU.

Pileus 1.5-2.5 cm, plano-convex with low umbo, surface dry, coarsely fibrillose with scattered appressed clusters of fibrils radiating around the disc, not rimose, in age becoming diffracted-scaly around the center, lacerate; "Cinnamon-Buff" (light yellowish brown or 2.5Y 6/4) to "Clay Color" (light brown or near 10YR 5/3-5/4), at times with fulvous center. Lamellae narrowly adnate to sinuate, seceding; close, about 40 L, with several tiers of lamellulae; about 2-3 mm broad; "Cinnamon-Buff" to "Snuff Brown"; edges pallid, distinctly fimbriate. Stipe 3.0 cm X 3-4 mm, often longer than pileus diam, even, not bulbous, white to light brown, silky-fibrillose, at times scurfy, not pruinose, veil status not confirmed; odor and taste not recorded. No pigments dissolving in alkali mounts.

Basidiospores (7.5-) 8.0-*9.1*-10.0 (-10.5) x (4.5-) 5.0-*5.2*-6.0 μm; Q=(1.50-) 1.60-*1.71*-1.91 (-2.00) (n=41/2), smooth, subamygdaliform, elliptic, or occasionally subphaseoliform, apices bluntly pointed or obtuse; "Ochraceous-Tawny" or yellowish brown to strong brown (10YR 5/6-7.5YR 5/8); wall slightly thickened; germ pore absent, nondextrinoid; apiculus small and indistinct (Fig. 1a).

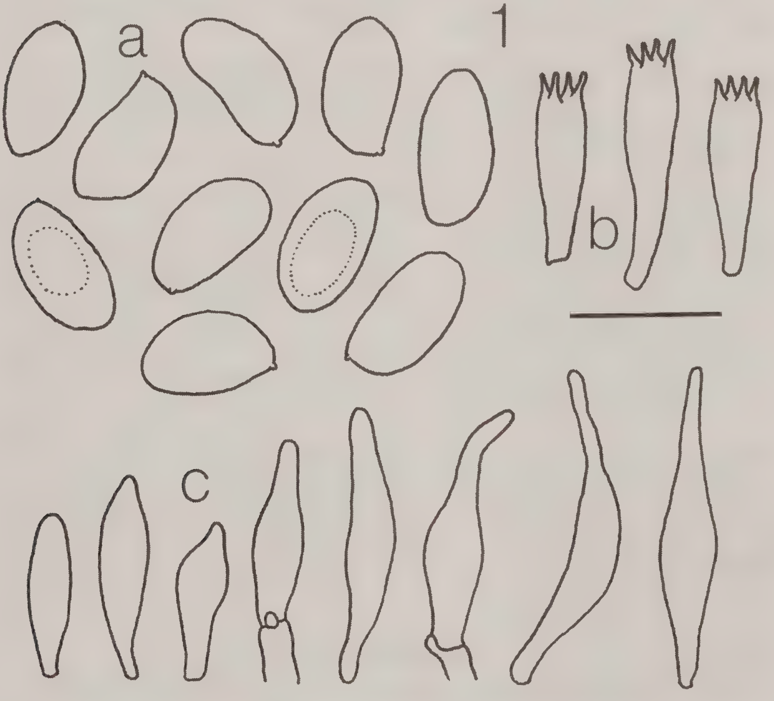

Fig. 1. Basidiospores (a), basidia (b), and cheilocystidia (c) of *Inocybe misakaensis* (holotype). The scale bar is equal to 10 μm for spores and 25 μm for basidia and cheilocystidia.

Basidia 27-35 x 8-10 μm (n=15/2), 4-stergimate, clavate to cylindrico-clavate, hyaline to necropigmented (Fig. 1b). Pleurocystidia absent. Cheilocystidia 26-61 x 7-10 μm (n=20/2), many fusiform with tapered subacute apices, at times rostrate, mixed with shorter clavate cells; thin-walled, hyaline to ochraceous or rusty colored, at times wall wrinkled or incrusted with pigment or cells with granular contents; lamellae edges sterile (Fig. 1c). Caulocystidia not observed; apex with sparse or thin superficial layer of hyphae, these cylindric, "Ochraceous-Tawny" in mass like the pileipellis, faintly incrusted if at all; tramal hyphae cylindric, very pale brown to yellowish with scattered golden refractive hyphae. Lamellar trama parallel, hyaline to very pale yellow, mostly cylindric but occasionally inflated, up to 16 μm diam, smooth, thin-walled; refractive hyphae present; cells unreactive in Melzer's solution. Pileipellis a cutis of interwoven or tangled to parallel cylindric hyphae, "Ochraceous-Tawny" in mass, hyphae mostly 3-10 μm diam, appearing smooth or at least not distinctly incrusted, at times filled with ochraceous-tawny refractive contents, thin-walled; tramal hyphae very pale brown to subhyaline in mass, cylindric; refractive hyphae present. Clamps present.

Scattered singly on soil among humus in seasonally burnt woodland (Miombo), including *Brachystegia, Gilbertiodendron*, *Isoberlinia*, and *Julbernardia* (caesalpinioid genera of *Fabaceae*) and *Uapaca (Uapacaceae),* Copperbelt Province, Ndola to Kitwe, Zambia (~15° S, 30° E), April.

Material examined: ZAMBIA: COPPERBELT PROVINCE: Misaka Forest Reserve, near Kitwe, 3 April 1991, leg. R. Watling, **Wat 24830** (E); same locality as above, on burnt patch, 3 April 1991, leg. R. Watling, **Wat 26674** (E); Ndola burn plots, seasonally burnt woodland, 2 April 1991, leg. R. Watling, **Wat 24837** (E, holotype; WTU, isotype).

Commentary: This species is characterized in part by the cinnamon buff to clay buff color, fibrillose texture, and presence of necrobasidia. However, the fusiform and rostrate cheilocystidia in combination with the paleotropical distribution in seasonally burnt woodlands represent unique characters. *Inocybe misakaensis* is probably ectomycorrhizal with caesalpinioid legumes such as *Brachystegia*, *Gilbertiodendron*, *Isoberlinia*, and *Julbernardia*, and/or *Uapaca* of the *Uapacaceae*. Indeed, a number of common Zambian trees in the *Fabaceae, Dipterocarpacae, Uapacaceae,* and *Proteaeae* have been reported as ectomycorrhizal (Högberg & Piearce 1986).

Inocybe misakaensis represents one of few depauperate (i. e., lacking pleurocystidia) species of *Inocybe* known from tropical Africa. *Inocybe aureoplumosa*, recently described by Watling (2001) from Cameroon, also possesses necrobasidia like *I. misakaensis* but morphologically is very different because of the brilliant reddish orange squamules on the pileus and stipe and subglobose spores. De Seynes (1897) described *I. erythroxa* from Gabon, which is colored like *I. aureoplumosa*, but lacks any ornamentation on the stipe and has elliptic spores. *Inocybe fastigiata* var. *brevispora* Heim described from Madagascar (Heim 1931) has a distinctly rimose pileus, short clavate cheilocystidia, and broadly elliptic to subglobose spores. Buyck & Eyssartier (1999) mention the resemblance of some endemic African species of *Inocybe* to *I. dulcamara*, but none of these have yet been described.

Phylogenetic results

A total of 18 accessions were used in this study. 730 positions were aligned in the data set that were sequenced from the 6 to 7 conserved domains of RPB2. The data set contains 242 parsimony-informative sites and 42 autapomorphic sites. The model best-fit to the RPB2 data is a Tamura-Nei model with equal base frequencies; rates of 10.07 and 5.73, respectively, for cytosine-thymine (CT) and adenine-guanine (AG) transitions and 1.00 for transversions; the proportion of invariable sites was estimated at 0.56 in addition to a gamma distribution of 3.38.

The ML analysis of RPB2 DNA sequences of *I. misakaensis* places it sister to section *Cervicolores* of the Inosperma clade (Matheny 2004) with moderately high (79%) bootstrap support (Fig. 2). The ML tree has a -ln L score of 4022.210. A single MP tree of 705 steps was recovered that differs from the ML tree only by the placement of a single branch, *I. adaequata* (Britz.) Sacc. (data not shown). In the MP tree *I. adaequata* is basal to *I. misakaensis* with poor (< 50%) bootstrap support.

The five major clades inferred in *Inocybe* by Matheny (2004) are represented in Fig. 2. *Inocybe misakaensis* is placed with strong bootstrap support (100%) in the Inosperma clade, which contains representatives of sections *Rimosae* (Fr.) Sacc. and *Cervicolores* Singer (Kuyper 1986) sampled from Europe, North America, and Australasia.

Necrobasidia is a plastic morphological trait

Inocybe misakaensis is more closely related to members of section *Cervicolores* that includes, for example, the widely distributed species *I. calamistrata* (Fr.: Fr.) Gillet. This relationship is demonstrated despite the presence of basidia that become ochraceous and collapse (necrobasidia) in *I. misakaensis*. The presence of necrobasidia is a trait that occurs in all samples of the Mallocybe and Auritella clades (Fig. 2). However, a collection of *I. calamistratoides* Horak from New Zealand also features necrobasidia and is strongly placed (100% bootstrap support) in section *Cervicolores* of the Inosperma clade. Thus, it appears that either necrobasidia have evolved more than once or have been repeatedly lost. In any case, the possession of necrobasidia cannot be emphasized as a synapomorphic trait in *Inocybe* (Kuyper 1986) although all accessions sampled to date in the Mallocybe and Auritella clades do have necrobasidia (Matheny 2004).

The unique cheilocystidia morphology and ecology of *I. misakaensis* are supported as distinct characters by the RPB2 phylogeny. Like *I. misakaensis*, only *I. aureoplumosa* from Cameroon (Watling 2001) has both necrobasidia and an association with African caesalpinioid trees. *Inocybe aureoplumosa*, however, is sister to several undescribed Australian taxa in the Auritella clade (Matheny and Bougher, unpublished).

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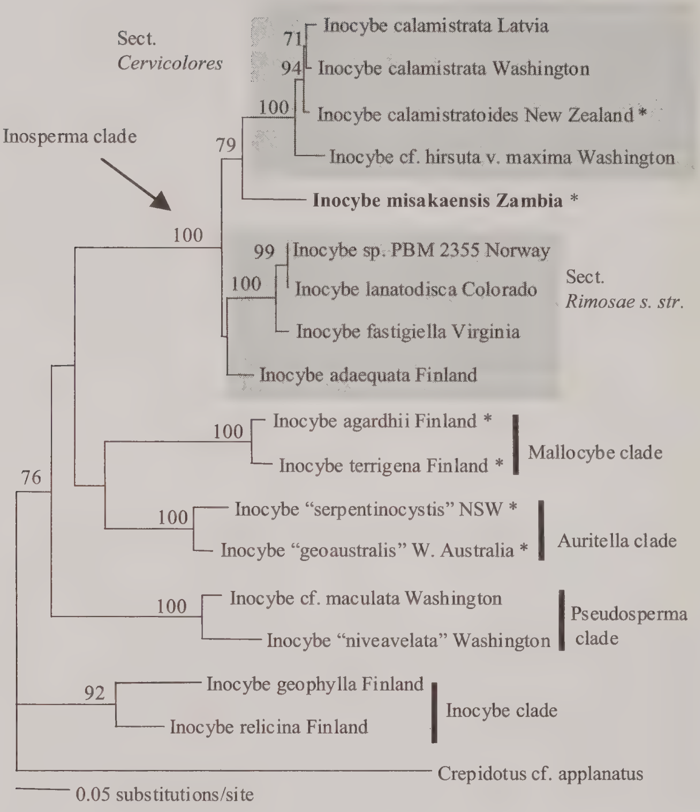
Sect.
Cervicolores
Inosperma clade
71
94
100
79
100
Inocybe calamistrata Latvia
Inocybe calamistrata Washington
Inocybe calamistratoides New Zealand *
Inocybe cf. hirsuta v. maxima Washington
Inocybe misakaensis Zambia *
99
100
Inocybe sp. PBM 2355 Norway
Inocybe lanatodisca Colorado
Inocybe fastigiella Virginia
Inocybe adaequata Finland
Sect.
Rimosae s. str.
100
Inocybe agardhii Finland *
Inocybe terrigena Finland *
Mallocybe clade
76
100
Inocybe "serpentinocystis" NSW *
Inocybe "geoaustralis" W. Australia *
Auritella clade
100
Inocybe cf. maculata Washington
Inocybe "niveavelata" Washington
Pseudosperma clade
92
Inocybe geophylla Finland
Inocybe relicina Finland
Inocybe clade
Crepidotus cf. applanatus
0.05 substitutions/site

Fig. 2. The ML tree distinguishes *I. misakaensis* (in bold type) from other depauperate taxa of the Mallocybe, Auritella, and Pseudosperma clades and the pleurocystidiate group, the Inocybe clade. The asterisk after a name indicates a necrobasidiate species. Sections *Cervicolores* and *Rimosae s. str.* are boxed in gray. This tree is inferred from nucleotide sequences of RPB2 conserved domains 6 to 7. Branch lengths are proportional to the number of substitutions per site. Bootstrap values greater than 50% derived from a maximum parsimony analysis are indicated above branches. Geographic origins for taxa are also indicated. *Crepidotus* is used to root the tree. NSW is an abbreviation for New South Wales.

Literature Cited

Buyck B, Eyssartier G. (1999). Two new species of *Inocybe (Cortinariaceae)* from African woodland. *Kew Bulletin* 54: 675-681.

De Seynes J. (1897). *Recherches pour servir à l'histoire naturelle et à la flore des champignons du Congo Français*. I. Massar et Cie, Paris.

Felsenstein J. (1985). Confidence limits on phylogenies: an approach using the bootstrap. *Evolution* 39: 783-791.

Heim R. (1931). Le genre *Inocybe*, encyclopedie mycologique 1. Paul Lechevalier & Fils, Paris, France.

Högberg P, Piearce GD. (1986). Mycorrhizas in Zambian trees in relation to host taxonomy, vegetation type and successional patterns. *Journal of Ecology* 74: 775-785.

Holmgren PK, Holmgren NH, Barnett LC. (1990). Index herbariorum. 8th edition. New York Botanical Garden, Bronx, New York, USA.

Kuyper TW. (1986). A revision of the genus *Inocybe* in Europe: I. Subgenus *Inosperma* and the smooth-spored species of subgenus *Inocybe*. *Persoonia* 3(Supplement): 1-247.

Liu YJ, Whelen S, Hall BD. (1999). Phylogenetic relationships among Ascomycetes: evidence from an RNA polymerase II subunit. *Molecular Biology and Evolution* 16: 1799-1808.

Matheny PB. (2004). Improving phylogenetic inference of mushrooms with RPB1 and RPB2 nucleotide sequences *(Inocybe; Agaricales). Molecular Phylogenetics and Evolution*: in press.

Matheny PB, Aime MC, Henkel TW. (2003). New species of *Inocybe* from *Dicymbe* forests of Guyana. *Mycological Research* 107: 495-505.

Matheny PB, Liu YJ, Ammirati JF, and Hall, B. D. (2002). Using RPB1 sequences to improve phylogenetic inference among mushrooms *(Inocybe, Agaricales). American Journal of Botany* 89: 688-698.

Munsell soil color charts (1954). Munsell Color Company, Inc., Baltimore 18, Maryland, USA.

Posada D, Crandall KA. (1998). MODELTEST: testing the model of DNA substitution. *Bioinformatics* 14: 817-818.

Posada D, Crandall KA. (2001). Selecting the best-fit model of nucleotide substitution. *Systematic Biology* 50: 580-601.

Ridgway R. (1912). *Color standards and color nomenclature*. Published by the author, Washington, D. C., USA.

Swofford DL. (2003). *PAUP*. Phylogenetic analysis using parsimony (*and other methods)*, Version 4. Sinauer, Sunderland, Massachusetts.

Thompson JD, Gibson TJ, Plewniak F, Jeanmougin F, Higgins DG. (1997). The ClustalX windows interface: flexible strategies for multiple sequence alignment aided by quality analysis tools. *Nucleic Acids Research* 25: 4876-4882.

Watling R. (2001). An unusual *Inocybe* sp. from West Africa. *Czech Mycology* 52: 329-334.

Appendix

Collections used for RPB2 nucleotide sequencing include: Inosperma clade: Section *Cervicolores: I. calamistrata* (JV 11950, TURA, WTU); *I. calamistrata* (PBM 2351, WTU); *I. calamistratoides* (ZT 96/30, ZT, WTU); *I.* cf. *hirsuta* var. *maxima* (PBM 1066, WTU); *I. misakaensis sp. nov*. (Wat. 24830, E, WTU). Section *Rimosae s. str*.: *Inocybe* sp. PBM 2355 (PBM 2355, WTU); *I. lanatodisca* (ST 99-229-01, WTU); *I. fastigiella* (JRH 408, WTU); *I. adaequata* (JV 16501F, TURA, WTU). Mallocybe clade: *I. agardhii* (JV 7485F, TURA, WTU), *I. terrigena* (JV 16431, TURA, WTU). Auritella clade: *I. "serpentinocystis"* (T25080, WTU, OSC); *I. "geoaustralis"* (H7344, CSIRO-PERTH, WTU). Pseudosperma clade: *I.* cf. *maculata* (PBM 525, WTU), *I. "niveavelata"* (PBM 2337, WTU). Inocybe clade: *I. geophylla* (JV 6374, TURA, WTU), *I. relicina* (JV 10258, TURA, WTU).

MYCOTAXON

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A new species of *Parmotrema* (Ascomycota: *Parmeliaceae*) from Portugal

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Abstract—*Parmotrema sampaioi* is described as new to science. This species is characterized by revolute lobes, the lack of cilia and vegetative propagules, and the presence of medullary protocetraric acid.

Key words—Europe, herbarium, lichen, Sampaio

Introduction

The Herbarium of the University of Porto (PO, Portugal) is housed in the Botanical Institute 'Dr. Gonçalo Sampaio', and is one of the more important herbaria in the Iberian Peninsula as it houses 122,000 herbarium sheets belonging to all plant and fungal groups. The lichen herbarium is represented by c. 9000 specimens and comprises a general herbarium with specimens from Europe, a Portuguese herbarium with local specimens, and several special collections, the most important being Gonçalo Sampaio´s collection with c. 4000 specimens, mostly from Portugal and collected in the first decades of the twentieth century. Lichen taxa described by Sampaio have recently been typified (Paz-Bermúdez et al. 2002), the identity of some critical collections re-determined and new records reported for Portugal (Paz-Bermúdez 2003).

Among the earliest collections from Portugal are some specimens collected at the end of the nineteenth century. These were sent to William Nylander for identification, and one such specimen forms the subject of this paper.

Materials and Methods

The morphology of the lichen specimen was examined using a Zeiss Stemi 2000C stereo microscope, and a Zeiss Axiolab compound microscope. Chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson et al. 1981; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix et al. 2003) and comparison with authentic samples.

Taxonomic Description

Parmotrema sampaioi Paz-Bermúdez & Elix, *sp. nov.* FIGURE 1

Thallus *ut in Parmotrema saccatilobum sed superfice superiore exisidiatus differt.*

Etymology: in honor of the Portuguese lichenologist Gonçalo Sampaio.

Type: **PORTUGAL**. Póvoa de Lanhoso: S. Gens, on granite rock, *Isaac Newton,* 25 Sept. 1880; holo: PO-2997L.

KEY CHARACTERS — **Thallus** saxicolous, foliose, loosely adnate, coriaceous, 9-12 cm wide. **Lobes** imbricate, subirregular, 4-12 mm wide, marginal and submarginal lobes becoming markedly saccate and revolute; margins crenate or irregularly incised-dentate, ascending or revolute; cilia absent; lobules present along the lobe margins, 0.5-1.5 mm wide, monophyllous or rarely branched, minutely ciliate, cilia 0.2-0.5 mm long. **Upper surface** gray, becoming gray-brown in the herbarium, flat to convex, emaculate, smooth to rugulose on older lobes; isidia and soredia absent. **Medulla** white. **Lower surface** black, with a brown erhizinate marginal zone; rhizines very rare or absent, simple, slender, to 1 mm long. **Apothecia** and pycnidia not seen. **Chemistry** — Cortex K+ yellow; medulla K+ pale yellow-brown, C-, KC-, P+ brick-red; containing atranorin (minor), chloroatranorin (minor), protocetraric acid (major), convirensic acid (minor), virensic acid (trace), subvirensic acid (trace).

Distribution — At present this species is only known from the type collection.

COMMENTS — This new species is characterized by the saccate-revolute, eciliate lobes, the lack of vegetative propagules, the marginal, minutely ciliate lobules, very sparse rhizines and the presence of medullary protocetraric acid. Morphologically *P. sampaioi* closely resembles *P. saccatilobum* (Nyl.) Hale and, in fact, W. Nylander identified this specimen as *Parmelia saccatiloba* Nyl. These two species have similar loosely adnate thalli which lack cilia and have saccate-revolute lobes, lack soredia and contain protocetraric acid in the medulla. However, *P. saccatilobum* can clearly be separated by the presence of cylindrical isidia on the upper surface (*P. sampaioi* is non-isidiate), and the absence of minutely ciliate lobules along the lobe margins.

The type locality, Póvoa de Lanhoso, has a rather unique lichen flora. It is one of the two Portuguese locations where *Erioderma mollisimum* (Samp.) DuRietz is known in continental Europe (Paz-Bermúdez et al. 2002; Jørgensen 2000).

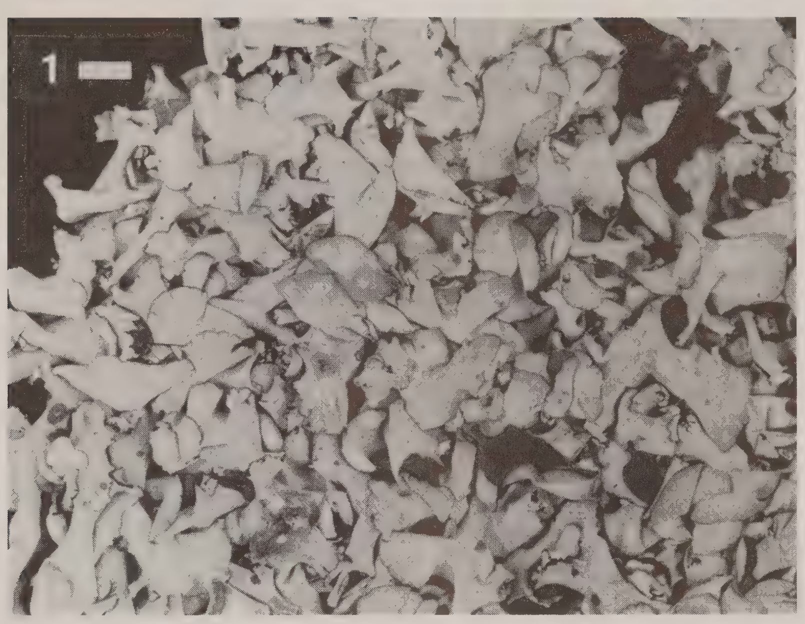

Figure 1. *Parmotrema sampaioi* (holotype in PO). Scale bar = 5.0 mm.

Acknowledgements

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Literature Cited

Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. Journal of Chromatography 72: 113-125.

Culberson CF, Culberson WL, Johnson A. 1981. A standardized TLC analysis of □-orcinol depsidones. Bryologist 84: 16-29.

Culberson CF, Johnson A. 1982. Substitution of methyl *tert*.-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. Journal of Chromatography 238: 483-487.

Elix JA, Ernst-Russell KD. 1993. A Catalogue of Standardized Thin Layer Chromatographic Data and Biosynthetic relationships for Lichen Substances (2nd Edition). Australian National University, Canberra.

Elix JA, Giralt M, Wardlaw JH. 2003. New chloro-depsides from the lichen *Dimelaena radiata*. Bibliotheca Lichenologica 86: 1-7.

Jørgensen, P. M. 2000. Survey of the lichen family *Pannariaceae* on the American Continent, North of Mexico. Bryologist 103: 670-704.

Paz-Bermúdez G. 2003. The identity of some lichens described from Portugal by G. Sampaio and W. Nylander. Nova Hedwigia 77: 115-123.

Paz-Bermúdez G, Aguiar-Branco H, Folhadela E. 2002. Typification of names of lichen taxa described by G. Sampaio and some others, deposited in Porto Herbarium (PO). Taxon 51: 771-785.

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Book reviews and notices

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General

Mycologia Balcanica. Editor in Chief Cvetomir M. Denchev. Vol. 1 (1). February 2004. Bulgarian Mycological Society, c/o Institute of Botany, Bulgarian Academy of Sciences, Acad. G. Bonchev Street, BG-1113 Sofia, Bulgaria. Pp. 73 + vi. ISSN not indicated. Price: € 43 (individuals) or € 58 (institutions) [Balkan Peninsular countries], € 58 (individual) or € 85 (institutions) [other countries].

It a pleasure to draw attention to a new "international mycological journal", especially one so well-produced. *Mycologia Balcanica* is the official English language journal of the Bulgarian Mycological Society; it is entirely in English. The first issue contains 18 original papers and one book review. Most papers are floristic or systematic, but cover a wide range of fungal groups (e.g. agarics, deuteromycetes, discomycetes, powdery mildews, pyrenomycetes, rusts, smuts) and countries (notably Austria, Bulgaria, Greece, Italy, Romania, Serbia, and Turkey). It is planned to publish one volume consisting of three parts each year.

The journal is large-format (slightly shorter than A4) and printed on coated (glossy) paper. The layout is first-rate, as is the reproduction of line drawings, but the few half-tones in this part are all very dark. Papers are refereed, and the 16 reviewers acknowledged as helping with contributions in this part are mainly specialists with international reputations. The standard of the papers included is consequently high, though I was sad to see the name of the fine colour photograph of *Clathrus ruber* on the front cover attributed to "P. Micheli : Pers." [Micheli cannot be credited as having validly published a species name as he is a pre-starting point author].

I have always been a strong advocate of publishing papers of regional interest in journals issued in the pertinent region; that is the best way of ensuring that the data are available to those working there. That English has been selected as the language to be used, also means that the results appearing here are also easily digested by those not fluent in languages of the region.

Further information is available on the Society´s web page (www.mycobalcan.com), which also has information on the contents of future issues. I was personally interested to see that 1(3) is advertised as containing a catalogue of the lichens and lichenicolous fungi of Bulgaria.

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[1] Books for consideration for coverage in this column should be mailed to the Book Review Editor (address above) in the first instance. Fax (+34) 91 857 3640; e-mail: myconova@terra.es.

The cost is very reasonable for a publication of this quality, no doubt a result of the support received from the Bulgarian Ministry of Environment and Water, Ministry of Education and Science, and Foundation ´Biodiversity´. The foresight in such government bodies supporting a journal of this type is to be commended, and hopefully this model of funding can be emulated elsewhere. The journal should be added to the subscription lists of all European mycological libraries, and those of major mycological centres world-wide.

Katalog over Makro- og Mikrosopp angitt for Norge og Svalbard. By Jon-Otto Aarnæs. July 2002. FungiFlora, P. O. Box 95, Blinderen, N-0313 Oslo, Norway. [Synopsis Fungorum Vol. 16.] Pp. viii + 412. ISBN 82 907724 27 6. Price: NOK 450.

This checklist of the macro- and microfungi of Norway (including Spitzbergen) deals with 14 286 names, of which 12 390 are accepted and 4191 treated as synonyms (with about 1000 more old and doubtful). The checklist includes chytrids and slime moulds, but not lichen-forming species, although lichenicolous fungi are covered. This is unfortunate as while the lichens are covered elsewhere as are the lichenicolous fungi (Santesson *et al.,* 2004) their inclusion would have made the whole so much more complete. In all, 4046 basidiomycetes, 2318 ascomycetes, 1270 'deuteromycetes', 211 chromists, 68 zygomycetes, and 286 myxomycetes are accepted.

For each accepted species, the entries include literature references to Norwegian records, and Norwegian common names are given where they exist, but no details of hosts or distribution in the country are provided. Dates of publication of genera are included, but inconsistently not those of species names.

Nevertheless, there is no question that this is a landmark publication for Norwegian mycology which by virtue of the comprehensive an painstaking indexing of the old as well as the new literature will be the starting point for all wishing to locate details of the reports of particular species in the country.

Santesson, R., Moberg, R., Nordin, A., Tønsberg, T. & Vitikainen, O. (2004) *Lichen-forming and lichenicolous fungi of Fennoscandia.*— Uppsala: Museum of Evolution, University of Uppsala.

Microfungi of Tropical and Temperate Palms. By Joanne E. Taylor & Kevin D. Hyde. September 2003. Fungal Diversity Press, Department of Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong S. A. R. [Fungal Diversity Research Series Vol. 12.] Pp. ix + 459. ISBN 962 86765 1 2. Price US$ 80.

The prospect of a single book covering all that is known of the microfungi on palms is attractive and much needed, but that would be a Herculean task. This book is not that, but an approach to the problem. Following a well-referenced overview of the current state of knowledge, the rationale of this study is explained. Three species of palms were selected (*Archontophoenix alexandriae, Cocos nucifera,* and *Trachycarpus fortunei*) and sampled in Australia, China (Hong Kong, Hubi, and Hunnan), Malaysia, Singapore, Switzerland, and the UK. The bulk of the work (344 pages) is devoted to keys and accounts of the 288 species in 153 genera encountered. One genus (*Tribulatia*) and 34 species are described as new. The species accounts include bibliographic citations, detailed descriptions, information on cultural features (where isolated), ecology and distribution, and in many cases first-rate photomicrographs. Tables comparing microscopic features of different collections and also with those already published are an especial feature that is rarely emulated. This section makes this book a 'must have' for those working on the identification of palm fungi, but caution needs to be applied in following some of the citations of older names; there is even a 'Link ex Fr.' (p. 369). The work concludes with an overview and analysis of the data, much of which has appeared in previous papers but had not been brought together in this way. Interestingly, only 26 of the species appeared to be host specific, and the species found in particular sites appeared to be limited by climate, specific site conditions, and the status of the host palm in that locality. Attention should also be drawn to the Appendix detailing fungi previously descibed from these particular palms. In summary, a significant and useful contribution to our knowledge of palm fungi on which others can build.

Basidiomycetes

Contribution to the knowledge of genus *Agaricus*. By Luis A. P. Sánchez. 2003. Candusso, Alassio, Italy. [Fungi non delineati Pars XXIV.] Pp. 108, coloured photographs 48, figs 24. ISSN 1128 6008. Price: Unknown.

This is another volume in the series *Fungi non delineati*, published by Candusso from Italy which started in 1997. Twenty-four volumes in only seven years is an amazing result. The layout is the same as in the other 23 volumes: a number of rare or unknown species are described, the original diagnosis is given, and all species are depicted with colour photographs of the fruit bodies, and also line-drawings of microscopical structures and fruit bodies. Furthermore, the basionym and synonyms and some comments on the taxonomy are given, and the material examined is cited.

In this case this has resulted in a booklet of 108 pages, bilingual since everything is given in Spanish as well as in English. An Introduction of *ca* 1.5 pages gives a list of the characters which are considered constant (taxonomically useful?) by the author. Twelve species are described and depicted, all rare or uncommon in Spain. The order of the species is strictly alphabetical, but there is no reference to the numbered colour plates. The 48 colour plates are of good quality and seem to reproduce the natural colours, although not always typical or fresh specimens are shown. The picture of *Agaricus bohusii* for instance looks a bit dried out. One picture is given of *A. pseudolutosus*, which is not described. The line-drawings are somewhat roughly inked, but in general give a good impression of the features.

Unfortunately the English text has many spelling-mistakes and grammatical errors, and strangely enough the English and Spanish text do not always match.

In general the synonymy is the same as used in *Flora Agaricina Neerlandica* (Nauta, 2001), synonymizing for instance *A. benesii* and *A. squamuliferus*, *A. bernardii* and *A. maleolens*, *A. bresadolanus* and *A. romagnesii*, *A. lanipes* and *A. luteolorufescens*, and *A. subperonatus* and *A. pseudovillaticus*.

I have, however, a few critical remarks. It is a pity that the author did not always compare his collections with material from abroad. *A. lanipes* is only based on two collections, and the colour photographs do not look so very typical. *Agaricus moellerianus,* for instance, is only based on one collection. Although a rare species in most countries in Europe it can be observed regularly, and the difference from *A. campestris* is not always that clear. The strong yellow discoloration which is mentioned is not always that strong or clear, and also occurs in *A. campestris* var. *equestris*.

The described and depicted *A. lutosus* looks remarkably similar to what was formerly called *A. semotus* (and should be called *A. dulcidulus* in my opinion) which is in northern Europe very common and morphologically rather variable. *Agaricus lutosus*, as Møller defined it, differs from "*A. semotus*" only in the stipe tapering at the base and the yellowish pileus with only a few vinaceous fibrils when young.

But these remarks do not detract much from the value of this booklet. It is very useful for those interested in the subject, and a valuable addition to other existing books because of the combination of good coloured photographs and elaborate descriptions.

Nauta, M. M. (2001) *Agaricus*. In *Flora Agaricina Neerlandica* (M. E. Noordeloos, T. W. Kuyper & E. C. Vellinga, eds) **5**: 23-61. — Lisse: Balkema Publishers.

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Il Genere *Cortinarius* in Italia. Parte prima. By Giovanni Consiglio, Daniele Antonini & Massimo Antonini. 2003. Associazione Micologica Bresadola (AMB), Via Alessandro Volta 46, I-38100 Trento, Italy. Ring binder, pp. 64 + 50 loose-leaf profiles each of 4 perforated pages. Price: € 50.

The book is the first volume of a monograph of *Cortinarius.* It is being prepared by three specialists of the Associazione Micologica Bresadola, which has already published several other very interesting works on different genera. In the present volume, the 50 first species are presented, as the commencement of a book on a genus not very frequently studied. The authors hopefully announce an annual publication of new chapters. The book has a prologue, written in French by André Bidaud, a cortinariologist co-author of the already classical *Atlas des Cortinaires*.

The description of species is preceded by an introduction of two chapters. The first provides a comparative study of the two classification systems proposed for the genus *Cortinarius* genus, the Nordic *Flora Photografica*, which divides genus into four subgenera, and the French *Atlas des Cortinaires*, where the species are classified in six subgenus. They also cite the historic concept of Moser in *Die Gattung Phlegmacium*, which is specific for that subgenus. The authors of the present book do not make a choice, but give instead in each profile the classification according to the different systems. An extensive bibliography of around 200 references concludes the first chapter. The second part of the introduction, by Alfredo Vizzini, is entitled 'Secondary metabolites of *Cortinarius* s.l. species'. This is a study that goes deeply into the toxicological and pharmaceutical aspects of the genus, and includes also a specific bibliography on this subject. The authors announce that in future issues other general subjects related to the genus will be treated, including history, ecology, chorology, macrochemical reactions, etc.

As regards the descriptive section of the work, there are 50 species profiles, each of four pages, with an emphasis on the subgenus *Phlegmacium*, represented here by 28 species. Each profile includes an exhaustive taxonomic analysis, which places the species in the genus according to the alternative systematic proposals mentioned, and also incorporates the original Latin diagnosis (translated also into Italian), information on the etymology of the name, and a discussion of its taxonomic classification. The descriptive part itself is quite detailed, and comprises macroscopic and microscopic elements, reactions with KOH, and references to the habitat. However, a more extensive reference to macrochemical reactions, which are often the determinants of identifications in the genus, would have been desirable and welcomed. With respect to the images, each profile includes two colour photographs of excellent quality, an SEM micrograph, and a black and white sporogram giving maximum and minimum sizes of length, width and the Q ratio. A regional distribution map for the species in Italy is also presented in each profile.

This is an excellent book, and a very good complement to the existing works on *Cortinarius* in the context of the mediterranean area. I hope that the annual issuing rate will be realized, and expect that the work will help promote the interest of the mycological community to this large and passion-generating genus.

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A Preliminary Monograph of *Lentinellus* (*Russulales*). By Ronald H. Petersen & Karen W. Hughes. March 2004. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin. [Bibliotheca Mycologica No. 198.] Pp. 268, figs 51, tables 18, col. plates 13. ISBN 3 443 59100 0. Price € 80.

As leader of the London Fungi Recording Group, in the autumn of 2003 I collected a species of *Lentinellus* from Epping Forest, to the north of London. Upon examining the collection both macro- and microscopically, it soon became apparent to me how difficult it was to assign this particular specimen to a species utilising personal and available literature in the library at the Royal Botanic Gardens Kew.

The species I collected was eventually named as *L. ursinus,* but to my mind and others, certain macroscopic features didn't seem to fit with *L. ursinus*, so a nagging uncertainty surrounded my collection.

Upon a recent visit to David Hawksworth, who knew of my problem, I was presented with this new preliminary monograph of the genus *Lentinellus* to utilise and then review. The monograph accepts 24 species, based on a study of worldwide collections.

The introduction to the monograph includes an engrossing section on the historical lineage of *Lentinellus*, leading to the molecular discovery of an evolutionary connection between *Lentinellus* and the *Russulaceae* — fascinating stuff, but the amateur mycologist will need a copy of *Ainsworth & Bisby's Dictionary of the Fungi* by their side to decipher some of the terms. The taxonomic characters of *Lentinellus* are dealt with fully in descriptions and line drawings, making the inherent characteristics of particular species clear and easy to follow. Materials and Methods, along with microscopic techniques are given in this section, also giving a good explanation on how the authors reached their conclusions. *Hemicybe* continues to be treated as a synonym. The key is a simple dichotomous one that is easy to follow.

The descriptions of the accepted species, including cultural morphology and sexual mating compatibilities, are presented in depth, complete with diagrams of microscopic features and colour plates which cover 16 species. There is an excellent commentary section accompanying each species, outlining important information. Many species are lecto-, neo-, or epitypified for the first time. The inclusion of a table of spore statistics for each species as given by different authors and from different collections is also a most useful feature. I also welcomed the reproduction of copies of original illustrations of the species. The copy of Sowerby's illustration of the species now called *L. vulpinus* (originally described from north London) and the detailed notes on smell leave us in no doubt that this was the species we had from Epping Forest.

Going by own experience with the genus *Lentinellus,* this monograph gives an excellent insight into the genus and will prove to be a valuable addition to the growing number of modern generic revisions. Its depth and clarity make it a model to be emulated by others undertaking revisions of macromycete genera.

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Some Neotropical Wood-Inhabiting Fungi. Edited by Leif Ryvarden. 2002. FungiFlora, P. O. Box 95, Blindern, N-0313 Oslo, Norway. [Synopsis Fungorum Vol. 15.] Pp. 80. ISBN 82 907724 26 8. Price: NOK 120.

This is a collection of seven papers by various authors focussing on neotropical wood-inhabiting basidiomycetes. In all, four new genera, 12 new species and 10 new combinations are included for fungi which are generally perceived as relatively well-known in the region. There is a key to *Kneiffiella* (7 spp.) but without a discussion of its separation from *Hyphodontia, H.* sect.

Alutaceodontia is raised to generic rank, the new genus *Leptocorticium* is introduced for *Corticium cyatheae, Hydnodon* (based on *Hydnum thelephorum*) is synonymized with *Trechispora,* seven new *Inonotus* species are described (and a key to the 24 neotropical species now recognized provided). In addition, 155 species are reported from Paraná State in Brazil (five new to science, with keys to the neotropical *Antrodiella,* and *Coltrichia* species, and the world *Grammothelopsis* species), and seven new to Venezuela. In summary, something of a *potpourri,* but together making a significant contribution to our basic knowledge of neotropical corticioid and polyporaceous fungi.

A Critical Checklist of Corticioid and Poroid Fungi of Norway. By Leif Ryvarden, Jogeir Stokland & Karl-Henrik Larsson. February 2003. FungiFlora, P. O. Box 95, Blindern, N-0313 Oslo, Norway. [Synopsis Fungorum Vol. 17.] Pp. 109. ISBN 82 907724 28 4. Price: NOK 120.

This checklist accepts 204 poroid and 439 corticioid fungi, 36 species of which are new records for Norway post-Aarnæs (see above) and two are new to science (*Oligoporus hydnoidea* on *Picea,* and *Tyromyces vivii* on *Populus*) and one is a new combination. Keys to the European species of *Antrodiella* (14 spp.) and *Skeletocutis* (21 spp.) incorporated mean that the work will be of widespread interest to workers on these fungi. Much of the new work is a result of studies in 1995-97 of 160 selected sites, mainly in south-eastern Norway, which generated a massive 26 000 collections of fungi in these groups. For each species listed, there are notes of the number of records, indicated by province for less frequent species, and with more precise details for the rarest. No synonyms are provided or cross-referenced, but that information is mostly available from Aarnæs' catalogue. As so many additions were generated from one regional study in the country, it is clear that much more remains to be found in these groups even in Norway where they have probably been more intensively investigated than almost any region in the world.

Annotated list of Heterobasidiomycetous Fungi for the Iberian Peninsula and Balearic Islands. By Margarita Dueñas. 2002. J. Cramer in der Gebrüder Borntraeger Verlagsbuchhandlung, D-14129 Berlin, Germany. [Bibliotheca Mycologica No. 196.] Pp. 90, figs 1, tables 3. ISBN 3 443 59098 5. Price: € 32.

This comprehensive checklist, published in English, is part of the *Flora* (sic!) *Micológia Ibérica* project and is intended as a precursor to a future regional monograph of the Portuguese and Spanish heterobasidiomycetes. Rusts and smuts are excluded, as are the heterobasidiomycetous yeasts, but included are all the teleomorphic species in the *Atractiellales*, *Auriculariales*, *Dacrymycetales*, *Exobasidiales*, *Platygloeales*, *Septobasidiales*, *Tremellales*, and *Tulasnellales* (all *sensu* the 1995 edition of *Ainsworth & Bisby's Dictionary of the Fungi*). The checklist is arranged alphabetically by order, genus, and species, and provides full literature references for each taxon and for the synonyms used in the region, details of type specimens or type localities, distribution by province, details of reported substrata, and a record of herbaria containing voucher collections. Appendices include a list of taxa by province, and a bibliography of the literature surveyed to compile the list.

The checklist will clearly be of value to anyone interested in heterobasidiomycete distribution, not only in the Iberian Peninsula but throughout Europe and further afield. Though some critical work has been undertaken (as evidenced in the author's other papers and in footnotes in the text), the checklist relies substantially on unconfirmed reports and includes a number of highly dubious taxa which require further research. This, presumably, will be the next step in preparing a more thorough, regional mycota. Inevitably, there are also quite a few errors in author citations (the dubious old name *Tremella intumescens*, for example, should be credited, if that is the right word, to the Englishman J. E. Smith rather than the Norwegian Sommerfelt), and in literature references (particularly old ones), both of which need further attention before a mycota is prepared.

There is certainly quite a lot of work still to do. According to the appendix, the best recorded province (Madrid) has 51 heterobasidiomycete species listed, but more than 25 other Iberian provinces have five or fewer. At least this volume should make the task easier, and as such is much to be welcomed.

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The Rust Fungi of the British Isles: A guide to identification by their host plants. By D[ouglas] M. Henderson. 2004. British Mycological Society, Joseph Banks Building, Royal Botanic Gardens, Kew, Richmond-upon-Thames, Surrey TW9 3AE, UK. Pp. 35. ISBN 0 95227704 9 0. Price: Not indicated.

This is a complement to the checklist published by the same author in 2000 (see *Mycotaxon* **77**: 505, 2001), providing notes on the rusts reported arranged by host families and genera, with indications of the states to be expected and in some cases other hints to help in their separation. An Appendix provides updates, additions and corrections to the 2000 list. There is no doubt that this is a valuable adjunct to the checklist, but together they are still a supplement rather than a replacement for the seminal *British Rust Fungi* (Wilson & Henderson, 1966).

Wilson, M. & Henderson, D. M. (1966) *British Rust Fungi.* — Cambridge: Cambridge University Press.

Lichen-forming Fungi

The Macrolichens of Ohio. By Ray E. Showman & Don G. Flenniken. April 2004. Ohio Biological Survey, P. O. Box 21370, Columbus, Ohio 43221-0370, USA. [Ohio Biological Survey Bulletin, new series Vol. 14(3).] Pp. iv + 279. ISBN 0 86727 149 3. Price: US$ 35.

The Ohio Biological Survey has long been aware of the importance of lichens in its biota, having previously published accounts of the foliose and fruticose species (Taylor, 1967, 1968). However, those works are now long out of print and inevitably somewhat dated. Ray Showman has been working on the lichens of the state since the early 1970s, and the two authors produced a checklist of its macrolichens back in 1990 (Flenniken & Showman, 1990). Since then, Don produced a colour-illustrated treatment of the lichens of West Virginia state (see *Mycotaxon* **74**: 511-512, 2000). Now they have combined to produce an update of Taylor's work in a single new book, which includes all 223 macrolichens currently known from the state, with a checklist to facilitate cross-linking with names used by Taylor. After a basic and sound introduction, there is a key to genera, which are treated alphabetically, and then keys to species within each genus. Each species has a description, a summary of diagnostic features (helpfully in bold type), notes on ecology and chemistry, a distribution map (by county) and cross-references to colour photographs in *Lichens of North America* (see *Mycotaxon* **82**: 481-482, 2002) or Flenniken's earlier book. The only photographs included, apart from six on the front cover, are of the authors. Common names are given for some species, a practice I always think suspect when these are hardly known -- for example, how many lichenologists would know what the Powdery Sunburst Lichen was (actually *Xanthoria ulophyllodes*)? The book is well-presented and the ring-binding facilitates easy use. Now with this and the two recommended books to hand, there should be no excuse for passing Ohio macrolichens by. Now we await a companion volume on the crustose species in the state . . .

Flenniken, D. G. & Showman, R. E. (1990) The macrolichens of Ohio: a revised checklist. *Ohio Journal of Science* **90**: 130-132.

Taylor, C. J. (1967) *Lichens of Ohio*. Part 1. *Foliose Lichens*. [Ohio Biological Survey Bulletin, Biological Notes No. 3.] — Ohio State University, Columbus.

Taylor, C. J. (1968) *Lichens of Ohio*. Part 2. *Fruticose and Cladoniform Lichens*. [Ohio Biological Survey Bulletin, Biological Notes No. 4.] — Ohio State University, Columbus.

Líquenes de la Reserva Natural Integral de Muniellos, Asturias. By Eva Barreno Rodríguez & Sergio Pérez-Ortega. December 2003. Consejería de Medio Ambiente, Ordenación del Territorio e Infraestructuras del Principado de Asurias y KRK Ediciones, Álvarez Lorenzana 27, ES-33006 Oviedo, Spain. [Cuadernos de Medio Ambiente, Serie Naturaleza No. 5.] Pp. 512, col. figs 133. ISBN 84 96119 36 X. Price: € 30.

This book, based on the PhD thesis of the second author, examines the lichens and lichen communities in the Reserva Natural Integral de Muniellos in Asturias, northern Spain. The site is one the six UNESCO MAB [Man and the Biosphere] reserves in Spain, covers 542 ha, and has peaks rising to 1678 m (Pico zos Redondo). The rocks are quartzite, sandstones, shales and slates. In all, 430 species are treated, 45 % occurring on trees, and 60 % of which are crustose. The lichens in the area are clearly very lush, with *Lobaria amplissima* attaining 45 cm diam, and its *'Dendriscocaulon'* up to 2.5 cm tall. Identification problems were sometimes encountered, populations having 'deviant traits'. Nitrophilous communities are hardly developed, suggesting it is relatively free of the nitrogen pollution which is now so widespread in Europe, and making this an exceptional site for Atlantic lichens. The overall species list, while commendable, does seem to have some surprising absences (e.g. *Bryoria smithii* is included but not the usually commoner *B. bicolor*) and could surely be extended by further work. In executing the study 70 sites were concentrated on for sampling and this focussing, while pragmatic for a PhD, might have led to species being missed by more widespread searching. I also found it frustrating that precise localities were not given; perhaps this was deliberate to discourage collecting in the richest sites in the interests of conservation!

But this is much more than a floristic account, as in includes detailed descriptions and keys, and also a very full introduction (112 pp.), an extensive glossary illustrated by numerous line drawings, and an impressive literature list (with 21 web site sources also given on p. 492). Further, the 133 fine colour photographs include 35 of communities and habitats, and 98 of particular species. It is these elements that will ensure that this work will be widely used in Spanish-speaking countries. For those that are not familiar with Spanish, there is an extensive summary in English (pp. 35-43).

The authors are to be congratulated on this major contribution to our knowledge of lichens in the region, and by the back door publishing a general introduction to lichenology in Spanish at a very modest price well suited to a student's pocket.

The Epiphytic Lichens on *Quercus* in Sardinia (Italy) and their value as ecological indicators. By Luciana Zedda. 2002. Botanischen Garten und Botanischen Museum Berlin-Dahlem, Königin-Luise-Straße 6-8, D-4191 Berlin, Germany. [Englera Vol. 15.] Pp. 457, figs 38, tables 38. ISBN 3 9211800 49 8. Price: € 46.

This work is the product of a PhD thesis of which the lichenological supervisor was Harrie J. M. Sipman. The lichens on four *Quercus* species in 92 plots in 62 localities in Sardinia were examined, mainly in 1996-98. Over 3500 specimens were collected, representing 331 taxa, including the new species *Lecanora leuckertiana* (published elsewhere) and *Ramalina farinacea* var. *variolarica* (*ined.*). An amazing 75 species are first reports for Sardinia, and 13 of those species are new for Italy as a whole; this clearly shows what new information can be generated from closely focussed studies even on such a relatively well-explored island. Half (51 %) of the species were crustose, 62 % reproduced sexually, and 31 % by soredia. The richest host was *Q. ilex*, with 256 species, and more species were found on trunks (287 spp.) than twigs (159 spp.). For each taxon treated, earlier literature reports and details of all collections are cited, followed by discussions of the occurrences, ecology, distributions (especially in Europe), and comments on their taxonomic status.

While a phytosociological classification is not attempted, three of the systems of analysis applied are of especial interest. Two sites score 100 in the Revised Index of Ecological Continuity (RIEC), both in the Marghine-Goceano area; these are clearly old-growth forests of major conservation importance. Disturbance is also scored by an ‘hemerobic’ seven-zone scale indicative of the extent of human activity, in which H6 is a ‘lichen desert’ and H0 represents no human impact. New here is an ‘Index of Microclimatic Dryness’ (IMD), defined as the number of widespread temperate species dived by the number of suboceanic species; the results were well-correlated with forest-type. For those wishing to make other analyses, extensive appendices include data by host and plot.

The whole is presented in the context of other studies of lichens on oak, though I would have expected more comparison in the case of *Q. suber* with the substantial analysis by Fos (1998) of those on cork oak throughout the Iberian Peninsula. That studied recorded 304 species on this oak, compared with 167 reported here on it in Sardinia.

In summary, this is not only an excellent example a study in the systematic-ecological Mediterranean lichenological tradition, but also a work of wider interest because of the taxonomic notes and approaches to the distributional and ecological analyses.

Fos, S, (1998) Líquenes epífitos de los alcornocales Ibéricos: correlaciones bioclimáticas, anatómicas y densimétricas con el corcho de reproducción. *Guineana* **4**: 1-507.

Conidial Fungi

Alternaria. By Tian-Yu Zhang. 2003. Science Press, Beijing. [Flora Fungorum Sinicorum Vol. 16.] Pp. xvii + 283, tables 1, figs 132, coloured plates 4. ISBN 7 03 011095 1. Price: 58 Yuan.

This volume is in the tradition of the series, endeavouring to fully describe and document all the species of the pertinent group reported from the People's Republic of China. It is, however, unusual in the focus on a particular 'genus', although this is not the first time this has has been done (e.g. *Aspergillus* in vol. 5, 1997). After a detailed introduction, the species are treated by host family, and alphabetically within each family. Keys are provided to species within each family, but there is no overall key which would have been most welcome in this 'genus'. Synonyms, descriptions, first-rate line drawings, hosts, collections studied, etc., are given for a staggering 123 taxa (including several newly described species and also an unnamed one on *Zingiber officinale*). Teleomorphs where known are indicated, but are not described or discussed. In addition, fourteen reported species are excluded for various reasons. Especially welcome are the coloured plates, each depicting the symptoms caused by 5-6 taxa.

Of especial value are the line drawings. These are mostly full-page, and in them the author has been at pains to pack in numerous conidia in order to fully show the variation within the collection from which they were made (which I was pleased to see was given).

Dr Zhang has extensive experience of these fungi, and I recall meeting him when he worked with John C. David at the International Mycological Institute in the early-mid 1990s.

Although there is a need to re-assess species concepts in such 'genera' by molecular methods and cross-infection experiments, such traditional monographs are necessary as the basis of such newer approaches and to enable identifications to be made in the interim. As such the author is to be commended on this major and painstaking publication, and it is a 'must' for the shelves of all who wrestle with identifying or researching these fungi.

***Mycosphaerella* and its Anamorphs: 1. Names published in *Cercospora* and *Passalora*.** By Pedro W. Crous & Uwe Braun. September 2003. Centraalbureau voor Schimmelcultures, P. O. Box 85167, 3508 AD Utrecht, The Netherlands. [CBS Biodiversity Series Vol. 1.] Pp. [viii] + 571, figs 30. ISBN 90 70351 49 8. Price: € 75.

The thought of wrestling with the names of all described cercosporoid fungi is enough to make most mycologists go weak at the knees, but not for this duo. This work treats an amazing 5720 names, more than 3000 of which were proposed in *Cercospora,* 659 of which are accepted, and about 550 in *Passalora* which is emended here to include *Mycovellosiella, Phaeoisariopsis p. p., Phaeoramularia,* and *Tandonella.*

The work starts with an historical account and notes on all pertinent generic names, including a key to all accepted cercosporoid and morphologically similar genera which will be of wide utility. However, only four genera are accepted as being 'true cercosporoid' ones: *Cercospora, Passalora, Pseudocercospora,* and *Stenella.*

The species are treated alphabetically by species epithet, with the genus name provided afterwards (but with no ','). Original places of publication are provided, together with those for listed synonyms, and also an indication of the herbarium in which the type is found (but without details of that collection). Most types have actually been studied by the authors, but this is not made explicit by each cited herbarium. Also provided is information on reported hosts and the countries from which the species are reported. References to key literature are also included, and synonyms are cross-referenced. There is also a host-index by plant genus.

A staggering 455 new scientific names are introduced, mainly new combinations but including some new names and newly described species. Hopefully the new taxa will be accepted as validly published by nomenclatural purists despite having the species epithet printed before that of the generic name . . . . Discussions and illustrations are minimal, which is understandable in the light of the scale of the work, but I am sure that specialists would have welcomed more information on the basis for the decisions taken.

Especially intriguing is the treatment of 281 names as synonyms of *C. apii s. lat.* This problem is discussed in some detail, and the cautionary note about describing further taxa within it as distinct merits heed, pending a more critical molecular phylogenetic analysis.

While this will not be the last word on the cercosporoid fungi, it will now be the key reference work and starting point for all future studies on them. The mycological community will now look forward to the promised companion volumes on other anamorphs of *Mycosphaerella.*

Myxomycetes

Myxomycetes of New Zealand. By Steven L. Stephenson. 2003. Fungal Diversity Press, Department of Ecology and Biodiversity, University of Hong Kong, Pokfulam Road, Hong Kong S. A. R. [The Fungi of New Zealand Vol. 3; Fungal Diversity Research Series Vol. 11.] Pp. xiv + 238, figs 44, col. plates 4. ISBN 962 86765 4 7. Price: US$ 50.

This is a model for regional accounts of any group of organisms. It is attractively produced, well presented with clear type and good line drawings, and is provided with four good colour plates, depicting 24 species. The text is authoritative but never wordy, and the descriptions are clear and reliable. Some information is given on distribution within New Zealand but as this is the first complete account of the myxomycetes from that country in book form it is not surprising that no overall data are available. After a concise introduction to biology and structure, keys to orders, families, genera and species are provided. Within each species account comments allow comparison with related or similar species and with other taxonomic literature. The nomenclature used is completely in line with current thinking and where there are differences of opinion the author clearly indicates which opinion he follows.

The only regret I have is that the author, a leading researcher in myxomycete ecology, has not had the space to develop this area of study in the book. One assumes that the richness of New Zealand biodiversity is due not only to its geological history but also to its current geographical position, offering a very wide range of habitats, and this would have been a topic of considerable interest.

With 180 species of myxomycetes so far recorded, New Zealand still offers great scope for the myxomycologist – this modest total will surely be doubled in time. This book provides a firm basis for such further study and the author and publishers are to be congratulated for producing such an attractive and useful book at a fairly moderate price.

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Miscellaneous

Codex Botanicus Linnaeanus. By Hermann E. Richter. [Edited by John Edmondson.] 2003. A. R. Gantner Verlag, Ruggell, Liechtenstein. [Distributed by Koeltz Scientific Books, P. O. Box 1360, D-61453 Koenigstein, German.] Vol. 1 (with a biographical sketch by H. Walter Lack and a translation of the introductory text by Sten Hedberg). Pp. 53 + xxxii +1102. Vol. II (Index alphabiticus by William Ludwig Peterman). Pp. iv + 202. [Regnum Vegetabile Vol. 140.] ISBN 3 906166 03 1. Price: € 360.

Although first published in 1840, this is a remarkable work, which I never heard any mycologist or (lichenologist) mention, and never saw until this reissue. Richter (1808-1876) was a medical doctor in what is now Germany who determined to produce a synthetic account of Linnaeus' works. He combined the different generic and species accounts, clearly indicating which work and edition they had come from, and presents them as a single text including descriptions, synonyms, and notes. He envisaged this as a work that could be used instead of Linnaeus' own books. The details of how he worked and his philosophy are given in an English translation of Richter's own introduction by Sten Hedberg. Walter Lack also provides background on Richter and his struggling career.

However, Richter did not produce an index to the names, that task being taken on by Petermann. What is most valuable is that Petermann's index includes polynomials, so that one can quickly find, for example, what polynomials starting with *Agaricus* or *Lichenoides* have been treated in Linnaeus' works and under what Linnaean names. This means that one can take classic texts such as those of Micheli and Dillenius and find if and how Linnaeus handled the polynomials these authors used in any of his books – not only *Species Plantarum.* I have already found this of value in recent months while investigating some mid-eighteenth century names, and only wish I had known about it 30 plus years ago when I first had to wrestle with pre-Linnaean names.

This is clearly a reference work bibliophiles and nomenclaturalists should be aware of, and one that all major taxonomic libraries have on their shelves – ideally filed next not only to Linnaeus' works but along with the also little known index to names in the dissertations of Linnaeus' students (Kiger *et al.* 1999).

Kiger, R. W., Tancin, C. A. & Bridson, G. D. R. (1999) *Index to Scientific Names of Organisms cited in the Linnean Dissertations together with a Synoptic Bibliography of the Dissertations and a Concordance for selected editions.* — Pittsburgh: Hunt Institute for Botanical Documentation.

MYCOTAXON

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Mycotaxon changes redux: Online index & new submission protocols

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New online index—Although *Mycotaxon* will continue to be rigorously indexed, we will no longer print an index at the end of each volume. Instead, the index will be posted on the *Mycotaxon* website (www.mycotaxon.com), from which it can be downloaded and printed. Plans are now underway to combine past and future indices into a robust *Mycotaxon* online search engine.

New submission protocols—This issue is the first to be prepared entirely (except for 6 photographic halftones) from electronic files. Although during the past 3 months your over-zealous Editor-in-Chief devoted too much time to text 'nit-picking,' last week's arrival of Adobe Creative Suite® has shed much-needed light on how to streamline *Mycotaxon* electronic submission. As most future Mycotaxon papers will also be generated from high-resolution PDF files, authors must have the Editor-in-Chief preview complete manuscript text using e-mail attachments before final submission. Text and graphics (TIF or EPS formats) files should remain separate during the pre-submission period.

Text. Electronic—Two types of text files are needed: *text without graphics* but with space for graphics insertion (_txt.doc), and *text with graphics* (_pix.doc). The Editor-in-Chief uses the former to generate PDFs and the latter to guide graphics placement. **Hard copy**—Authors need send only *one* manuscript copy (with graphics included) for editorial use with their cover letter, electronics files, and *two* peer review cover letters & checklists. The EIC will generate composite PDF files for press and index use.

Graphics. Electronic—Smaller JPGs are useful during pre-submission, but for final submission authors *must* submit a scaled-to-fit, high resolution TIF (line drawing, halftone) or EPS (gene tree, graph, diagram) file for *each* separate plate. Submit files up to 4,000k by Email or snail-mail files on CD (preferred), Macintosh zip disk (acceptable), or PC floppy (least desired). **Hard copy**—*Mycotaxon* still sends halftone plates prepared from photographic negatives to the press for high-resolution scanning and digital conversion. Halftones scanned from digital plates degrade, so authors *must never* submit digital halftones on photographic glossy paper for scanning..

Kudos—Thanks to Karen Gettelman (Index), David Hawksworth (Book Reviews), Grégoire Hennenbert (French Language), and Noni Vidal (Web) for continuing to fill their *Mycotaxon* editorial roles so efficiently. Special thanks are also due to Mycotaxon Editorial Board members & Else Vellinga for help with *Mycotaxon* 2004 Guidelines 1.0, and to Dick Korf (Business Manager) for comforting advice when most needed.

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ERRATA

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Page 366, line 6	for Hill 8133	read	Hill 8132

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Page 1, line 13	for: *latisporus*	read	*latifolius*

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"... a great big blue uncompromising brick of a book ... an instant classic. Anyone interested in identification of fungi, particularly in Asia, should get this book immediately. Mycology owes another debt to Dick Korf for his sympathetic and intelligent editing of this superb work." *Bibliography of Systematic Mycology* 10(6): xlviii-xlix. 1998.

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